Assembly and Operation of the

HEATHKIT™

LOW-POWER CW TRANSCEIVER

MODEL HW-7

TABLE OF CONTENTS

HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

INTRODUCTION

The Model HW-7 Heathkit Transceiver is a three-band QRP (low power) CW Transceiver with both built-in VFO and crystal transmit provisions. Band coverage is the CW portion of forty, twenty, and fifteen meters. The Transceiver can be operated from the Heathkit Accessory Power Supply Model HWA-7-1, an equivalent low impedance power supply, or batteries. The experienced amateur, QRP man, and novice alike will appreciate the dependability and versatility of this Transceiver.

Whether you use it for standby, camping, emergency operation, or your primary rig, the Transceiver will prove its worth. Band changing and tune-up are easily accomplished with pushbutton band selection and single-control Tuning. The light-weight and compact Transceiver has pushbutton crystal transmit provisions for the novice or QRP roundtables. Main tuning is accomplished through a 6-to-1 vernier that is virtually backlash free. A Relative Power meter, built-in sidetone, and carry-along size make the Transceiver a pleasure to operate.

Refer to the "Kit Builders Guide" for complete information on unpacking, parts identification, tools, wiring, soldering, and step-by-step assembly procedures.

PARTS LIST

Check each part against the following list. The key numbers correspond to the numbers in the Parts Pictorial (fold-out from Page 5).

NOTE: Any part that is packaged in an individual envelope with its part number on it should be placed back in the envelope after it is identified until it is called for in a step.

To order replacement parts, refer to the Price Each column and use the Parts Order Form furnished with this kit. If a Parts Order Form is not available, refer to "Replacement Parts" in the "Kit Builders Guide."

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
RESISTORS				
NOTE: All resistors are 1/2-watt, ±10% tolerance.				
A1	1-140	2	1.5 Ω (brown-green-gold)	.10
A1	1-41	1	10 Ω (brown-black-black)	.10
A1	1-103	1	33 Ω (orange-orange-black)	.10
A1	1-3	6	100 Ω (brown-black-brown)	.10
A1	1-6	3	470 Ω (yellow-violet-brown)	.10
A1	1-9	~~9~~ 10	1000 Ω (brown-black-red)	.10
A1	1-11	1	1500 Ω (brown-green-red)	.10
A1	1-16	4	4700 Ω (yellow-violet-red)	.10
A1	1-20	~~8~~ 2	10 kΩ (brown-black-orange)	.10
A1	1-21	1	15 kΩ (brown-green-orange)	.10
A1	1-22	1	22 kΩ (red-red-orange)	.10
A1	1-25	5	47 kΩ (yellow-violet-orange)	.10
A1	1-47	1	56 kΩ (green-blue-orange)	.10
A1	1-26	1	100 kΩ (brown-black-yellow)	.10
A1	1-126	1	180 kΩ (brown-gray-yellow)	.10
2-WATT RESISTORS-CONTROLS				
A2	1-20-2	2	100 Ω (brown-black-brown) resistor	.10
A3	10-222	1	50 kΩ LIN (linear taper) control	.45
A4	19-95	1	10 kΩ AUD (audio taper) control with switch	1.05
CAPACITORS				
Mica				
B1	20-77	2	24 pF	.15
B1	20-96	1	36 pF	.15
B1	20-101	2	47 pF	.15
B1	20-102	~~1~~ 2	100 pF	.15
B1	20-103	1	150 pF	.15
B1	20-105	3	180 pF	.20

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
Ceramic				
B2	21-155	1	33 pF	.10
B2	21-47	~~8~~ 5	.01 µF	.10
B2	21-143	7	.05 µF	.20
Polystyrene				
B3	29-20	2	1000 pF	.30
B3	29-21	1	1200 pF	.30
B4	27-62	1	.68 µF	.60
Electrolytic				
B5	25-123	5	2 µF	.40
B6	25-145	1	25 µF	.50
B7	25-117	3	100 µF	.50
B8	25-230	1	2000 µF	1.90
Variable				
B9	26-139	2	1-section	3.45
B10	26-140	1	2-section	4.65
B11	31-52	3	8-60 pF mica trimmer	.40
Other				
B12	28-4	1	1.5 pF phenolic (brown-green-white)	.10
B13	27-47 (1) .22	7	.1 µF Mylar*	.20
B13	27-86	1	.47 µF Mylar	.40
	27-52	2	.22 MF MYLAR	
COILS-CHOKES				
C1	40-1608	1	Driver coil	.90
C1	40-1624	1	Receiver antenna coil	.70
C2	40-1609	2	40 meter output coil	.55
C2	40-1610	2	20 meter output coil	.55
C2	40-1611	2	15 meter output coil	.55
C3	40-1612	1	VFO (variable frequency oscillator) coil	.65
C4	40-1619	1	Audio filter coil	.85
C5	40-1620	1	40 meter doubler coil	.45
C5	40-1621	1	20 meter doubler coil	.45
C5	40-1622	1	15 meter tripler coil	.45
C6	45-62	1	26 µH RF choke	.40
C7	45-82	1	350 µH RF choke	.40

*DuPont Registered Trademark

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
TRANSISTORS-DIODES-INTEGRATED CIRCUIT				
NOTE: Transistors are marked for identification in one of the following four ways: 1. Part number. 2. Transistor type number. 3. Part number and transistor type number. 4. Part number with a transistor type number other than the one listed.				
D1	417-116	1	S2091 transistor	.60
D2	417-274	1	40673 transistor	2.25
D3	417-224	2 *	MPSU05 transistor	1.10
D4	417-169	2	MPF105 transistor	1.50
D4	417-172	2	MPS6521 transistor	1.80
D5	417-118	2	2N3393 transistor	.40
D5	417-201	2	X29A829 transistor	.50
D6	442-4	1	CA3035V1 integrated circuit	3.90
D7	56-26	2	1N191 diode	.25
D7	56-55	1	VR-36A zener diode	1.00
HARDWARE				
#6 Hardware				
E1	250-138	9	6-32 x 3/16" screw	.05
E2	250-56	10	6-32 x 1/4" screw	.05
E3	250-127	4	6-32 x 1/2" self-tapping screw	.05
E4	250-250	1	6-32 x 1/2" black screw	.05
E5	250-170	11	#6 x 1/4" sheet metal screw	.05
E6	253-27	~~5~~ 1	#6 flat washer	.05
E7	254-1	11	#6 lockwasher	.05
E8	252-3	12	6-32 nut	.05
Control Hardware				
F1	253-10	4	Control flat washer	.05
F2	253-16	2	Control fiber shoulder washer	.05
F3	254-5	1	Control lockwasher	.05
F4	252-7	4	Control nut	.05
Miscellaneous Hardware				
G1	250-175	2	2-56 x 3/8" screw	.05
G2	250-34	3	4-40 x 1/2" screw	.05
G3	254-9	3	#4 lockwasher	.05
G4	252-51	2	2-56 nut	.05
G5	252-15	3	4-40 nut	.05
	253-1	2	6-32 LOCKER	

*Replaced with MPSU06 for RF parts

HEATHKIT®

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
WIRE-CABLE				
	344-55	1	Green wire	.05/ft
	344-2	1	Black stranded wire	.05/ft
	344-3	1	Red stranded wire	.05/ft
	343-15	1	Coaxial cable	.10/ft
ELECTRICAL PARTS				
H1	64-603	1	Switch assembly	4.30
H2	69-47	1	Relay	2.65
H3	407-135	1	Meter	4.65
H4	434-38	1	Crystal socket	.20
H5	434-107	1	Antenna socket	.40
H6	438-4	2	Antenna plug	.10
H7	436-20	2	Phone jack	.45
PINS-CONNECTORS				
J1	432-72	2	Male pin	.10
J2	432-73	2	Female pin	.10
J3	432-94	1	Chassis connector	.30
J4	432-95	1	Cable connector	.25
SHEET METAL PARTS				
K1	200-638	1	Chassis	2.90
K2	203-1429-1	1	Front panel	2.45
K3	203-1430-1	1	Rear panel	2.35
K4	204-1844	1	Rail	.65
K5	204-1845	1	VFO (variable frequency oscillator) bracket	.45
K6	90-566-1	2	Cabinet shell	3.50

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
MISCELLANEOUS				
L1	75-61	4	Cabinet nut	.10
L2	261-34	4	Foot	.10
L3	100-1608	1	Vernier	1.70
L4	446-602-1	1	Dial window	.50
L5	464-65-1	1	Dial	.65
L6	490-1	1	Alignment tool	.10
L7	490-5	1	Nut starter	.10
	462-257	1	Large knob	.55
	462-258	3	Small knob	.35
	85-1186-1	1	Circuit board	4.85
	391-34	1	Blue and white label	
	597-260	1	Parts Order Form	
	597-308	1	Kit Builders Guide	
		1	Manual (See front cover for part number.)	2.00
			Solder (Additional 3' rolls of solder, #331-6, can be ordered for 15 cents each.)	

The above prices apply only on purchases from the Heath Company where shipment is to a U.S.A. destination. Add 10% (minimum 25 cents) to the price when ordering from a Heathkit Electronic Center to cover local sales tax, postage, and handling. Outside the U.S.A. parts and service are available from your local Heathkit source and will reflect additional transportation, taxes, duties, and rates of exchange.

STEP-BY-STEP ASSEMBLY

Before you start to assemble this Kit, be sure to read the "Kit Builders Guide" for complete information on wiring, soldering, and step-by-step assembly procedures.

All resistors will be called out by their resistance value (in Ω, or kΩ) and color code. Capacitors will be called out by their type and capacitance value (in pF, or μF).

CIRCUIT BOARDS

You will install components on the circuit board in the following circuit board pictorials. Position all parts as shown. Follow the instructions carefully and read the entire step before performing the operation.

After you complete the circuit board, check to make sure that all connections are soldered and that there are no solder bridges between adjacent foils. If you find a solder bridge, refer to the "Kit Builders Guide" for information on correcting it.

( ) Turn the circuit board foil-side-up as shown in Pictorial 1-1. Then slide a hot soldering iron along the indicated edges of the circuit board. This will assure a good ground connection when the circuit board is mounted later.

Prepare the following wires by cutting them to the indicated length and removing 1/8" of insulation from each end.

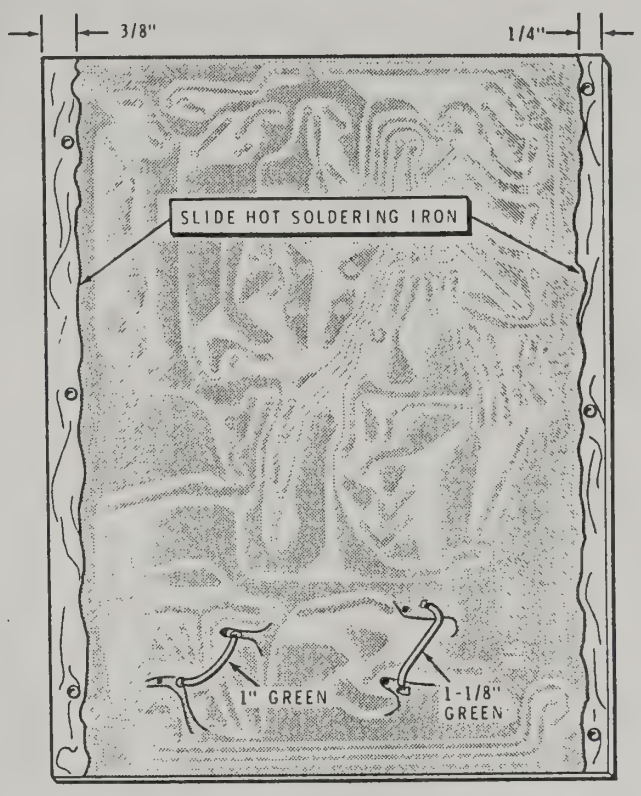
( ) 1" green

( ) 1-1/8" green

( ) Connect the 1" green wire between the indicated foil patterns as shown in Pictorial 1-1. Position the wire away from any circuit board holes.

( ) In the same manner, connect the 1-1/8" green wire between the indicated foil patterns.

NOTE: Only a portion of the circuit board will be worked on in each Pictorial. The identification drawing at the top of each Pictorial shows the area of the circuit board to be assembled.



PICTORIAL 1-1

SAFETY WARNING: Avoid eye injury when you clip off excess leads. We suggest that you wear glasses, or at least clip the leads so the ends will not fly toward your eyes.

( ) Position the circuit board component-side-up (lettered-side) as shown in Pictorial 1-2 and perform the following steps.

IDENTIFICATION DRAWING

START

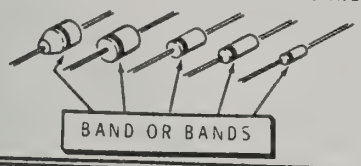
( ) 47 kΩ (yellow-violet-orange).

( ) 1000 Ω (brown-black-red).

( ) 10 kΩ (brown-black-orange).

( ) 47 kΩ (yellow-violet-orange).

NOTE: DIODES MAY BE SUPPLIED IN ANY OF THE FOLLOWING SHAPES. ALWAYS POSITION THE BANDED END AS SHOWN ON THE CIRCUIT BOARD.



( ) 1N191 diode (#56-26, brown-white-brown).

( ) 1000 Ω (brown-black-red).

( ) VR-36A diode (#56-55).

( ) 1000 Ω (brown-black-red).

( ) 4700 Ω (yellow-violet-red).

( ) 100 Ω (brown-black-brown).

( ) 10 Ω (brown-black-black).

( ) 1.5 Ω (brown-green-gold).

( ) 1.5 Ω (brown-green-gold).

NOTE: When you are instructed to install a jumper, remove 1/4" of insulation from both ends of the specified length of green hookup wire.

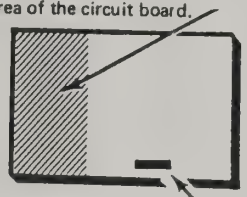
( ) 1-1/4" jumper.

( ) 1-1/2" jumper.

FOR GOOD SOLDERED CONNECTIONS, YOU MUST KEEP THE SOLDERING IRON TIP CLEAN... WIPE IT OFTEN WITH A DAMP SPONGE OR CLOTH.

( ) Solder the leads to the foil and cut off the excess lead lengths.

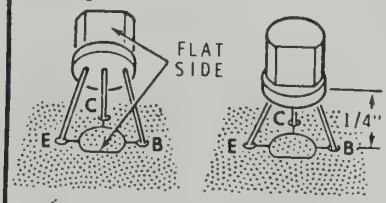
The parts installed in this Pictorial are in this area of the circuit board.



PICTORIAL 1-2

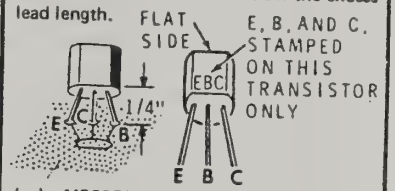
CONTINUE

NOTE: Install the following transistor by first lining up its flat with the outline of the flat on the circuit board. Then insert the transistor leads into their correct holes, indicated by E, C, and B. Solder each lead to the foil and cut off the excess lead length.



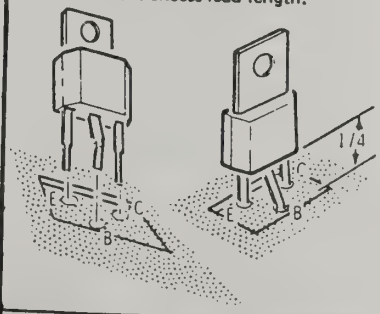
( ) X29A829 transistor (#417-201) at Q9.

NOTE: Install the following transistor by first lining up its flat with the outline of the flat on the circuit board. Then insert the transistor leads into their correct holes, indicated by E, B, and C. Solder each lead to the foil and cut off the excess lead length.



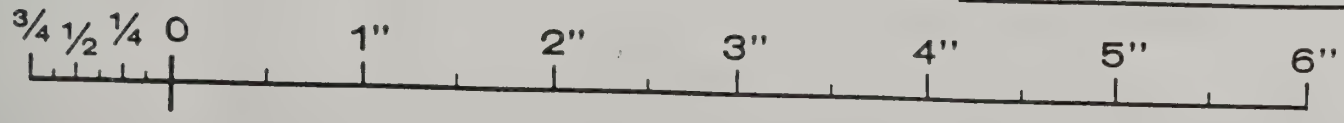
( ) MPS6521 transistor (#417-172) at Q5.

NOTE: Install the following transistors in the manner shown. First line up the flat of the transistor with the outline of the flat on the circuit board. Insert the transistor leads into their correct holes, indicated by E, B, and C. Solder each lead to the foil and cut off the excess lead length.



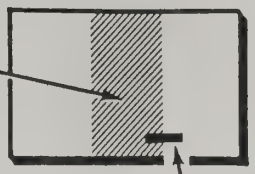
( ) MPSU05 transistor (#417-224) at Q6.

( ) MPSU05 transistor (#417-224) at Q7.



IDENTIFICATION DRAWING

The parts installed in this Pictorial are in this area of the circuit board.



START

( ) 4700 Ω (yellow-violet-red).

( ) 1N191 diode (#56-26, brown-white-brown). Position the banded end as shown.

( ) 4700 Ω (yellow-violet-red).

( ) 1000 Ω (brown-black-red).

( ) 100 Ω (brown-black-brown).

( ) 22 kΩ (red-red-orange).

( ) 470 Ω (yellow-violet-brown).

( ) 15 kΩ (brown-green-orange).

( ) 470 Ω (yellow-violet-brown).

( ) Solder the leads to the foil and cut off the excess lead lengths.

( ) 100 Ω (brown-black-brown).

( ) 100 Ω (brown-black-brown).

( ) 47 kΩ (yellow-violet-orange).

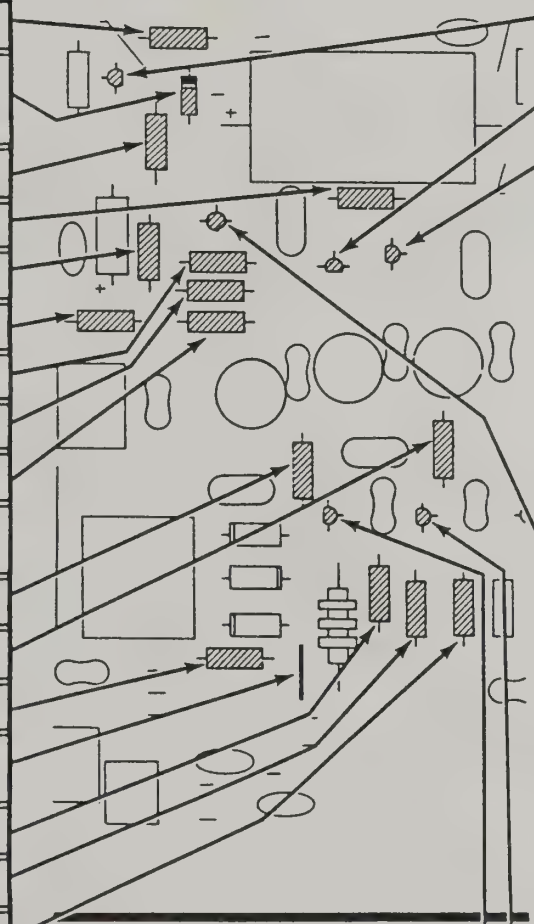
( ) 3/4" jumper. Remove all the insulation from the wire.

( ) 47 kΩ (yellow-violet-orange).

( ) 1000 Ω (brown-black-red).

( ) 10 kΩ (brown-black-orange).

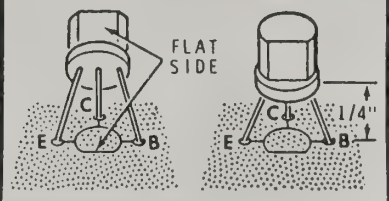
( ) Solder the leads to the foil and cut off the excess lead lengths.



PICTORIAL 1-3

CONTINUE

NOTE: Install the following transistors in the manner shown. First line up the flat of the transistor with the outline of the flat on the circuit board. Insert the transistor leads into their correct holes, indicated by E, C, and B. Solder each lead to the foil and cut off the excess lead length.

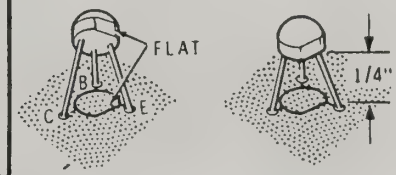


( ) 2N3393 transistor (#417-118) at Q8.

( ) X29A829 transistor (#417-201) at Q10.

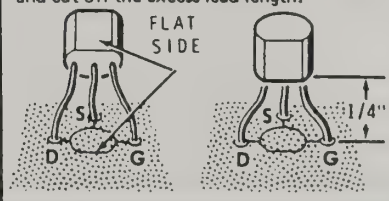
( ) 2N3393 transistor (#417-118) at Q11.

NOTE: Install the following transistor in the manner shown. Locate the wide space between the leads on the transistor. Then insert the transistor leads into their circuit board holes, which are indicated by C, B, and E. Position the transistor 1/4" above the circuit board. Solder each lead to the foil and cut off the excess lead lengths.



( ) S2091 transistor (#417-116) at Q12.

NOTE: Install the following transistors in the manner shown. First line up the flat of the transistor with the outline of the flat on the circuit board. Insert the transistor leads into their correct holes, indicated by D, S, and G. Solder each lead to the foil and cut off the excess lead length.



( ) MPF105 transistor (#417-169) at Q3.

( ) MPF105 transistor (#417-169) at Q2.

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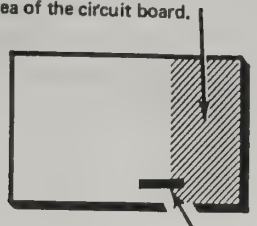
IDENTIFICATION DRAWING

The parts installed in this Pictorial are in this area of the circuit board.



START

( ) 3/4" jumper. Remove all the insulation from the wire.

( ) 4700 Ω (yellow-violet-red).

( ) 1000 Ω (brown-black-red).

( ) 33 Ω (orange-orange-black).

( ) 47 kΩ (yellow-violet-orange).

( ) 180 kΩ (brown-gray-yellow).

( ) 1000 Ω (brown-black-red).

( ) 10 kΩ (brown-black-~~orange~~ RED).

( ) Solder all leads to the foil and cut off the excess lead lengths.

( ) 1000 Ω (brown-black-red).

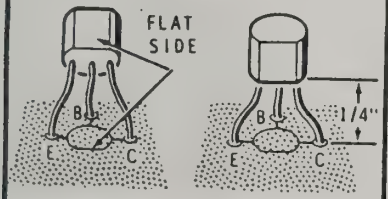
( ) 1000 Ω (brown-black-red).

( ) 100 Ω (brown-black-brown).

( ) 100 Ω (brown-black-brown).

( ) Solder all leads to the foil and cut off the excess lead lengths.

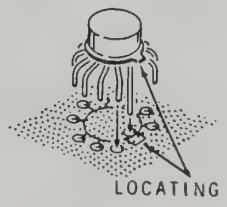
NOTE: Install the following transistor in the manner shown. First line up the flat of the transistor with the outline of the flat on the circuit board. Insert the transistor leads into their correct holes, indicated by E, B, and C. Solder each lead to the foil and cut off the excess lead length.



( ) MPS6521 transistor (#417-172) at Q4.

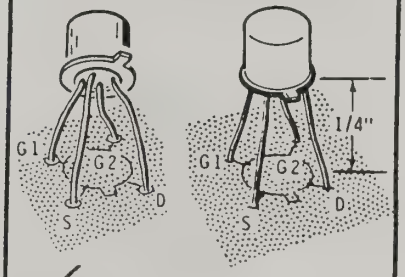
CONTINUE

NOTE: In the following step, install the integrated circuit in the manner shown. Line up the locating tab on the integrated circuit with the outline on the circuit board. Then insert the leads into their respective holes. Solder the leads to the foil and cut off the excess lead lengths.



( ) CA3035V1 integrated circuit (#442-4) at IC1.

NOTE: Install the following transistor in the manner shown. First line up the tab of the transistor with the tab outline on the circuit board. Then insert the transistor leads into their circuit board holes, which are indicated by S, G1, G2, and D. Position the transistor 1/4" above the circuit board. Solder each lead to the foil and cut off the excess lead length.



( ) 40673 transistor (#417-274) at Q1.

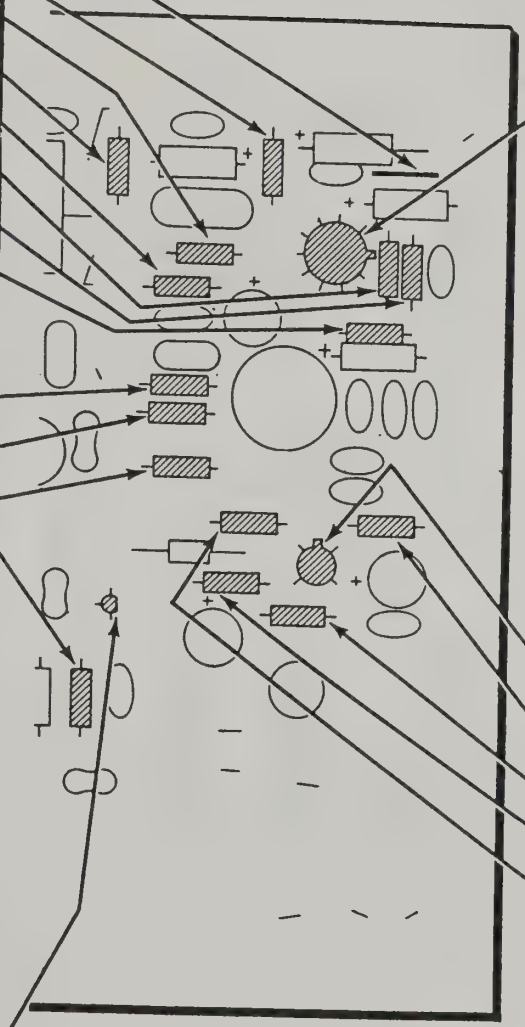
( ) 470 Ω (yellow-violet-brown).

( ) 56 kΩ (green-blue-orange).

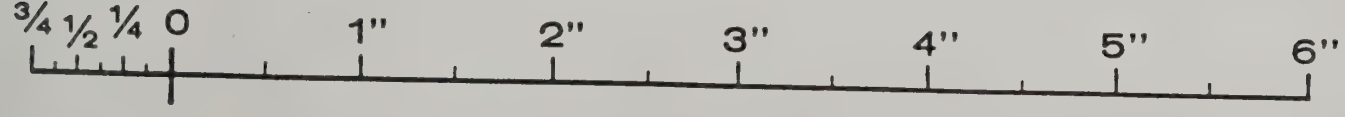
( ) 100 kΩ (brown-black-yellow).

( ) 1500 Ω (brown-green-red).

( ) Solder all leads to the foil and cut off the excess lead lengths.

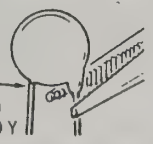


PICTORIAL 1-4



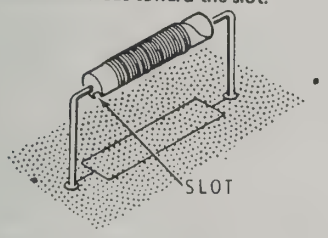
START

NOTE: Check the leads of each ceramic, mica or Mylar capacitor as you install it. Remove the coating from each capacitor as shown. This coating could cause a bad solder connection.

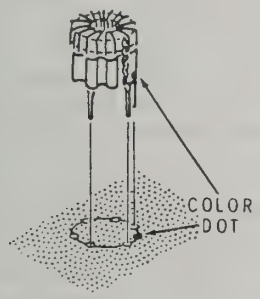


( ) .01 μF ceramic.

( ) 26 μH choke (#45-62) at RFC2. Bend the leads toward the slot.



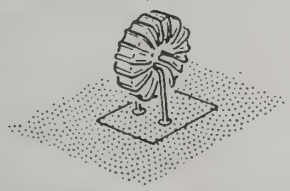
( ) Driver coil (#40-1608). Align the color dot on the coil with the dot on the circuit board. Press the coil into place and solder the pins to the foil.



( ) .1 μF Mylar.

( ) 47 pF mica.

( ) 15 meter output coil (#40-1611). Keep the coil within its outline on the circuit board.

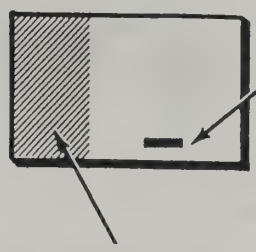


( ) 180 pF mica.

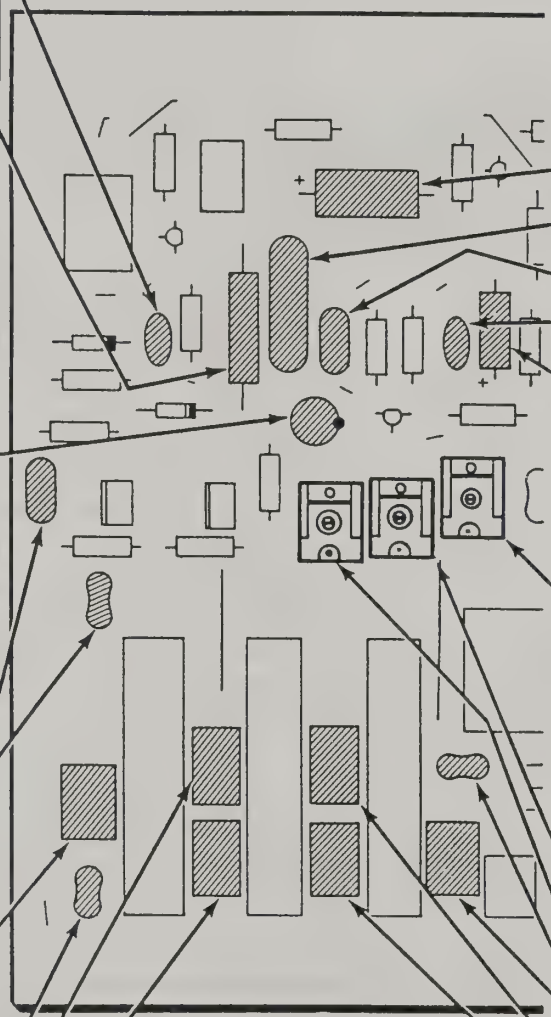
( ) 20 meter output coil (#40-1610).

( ) 15 meter output coil (#40-1611).

( ) Solder the leads to the foil and cut off the excess lead lengths.

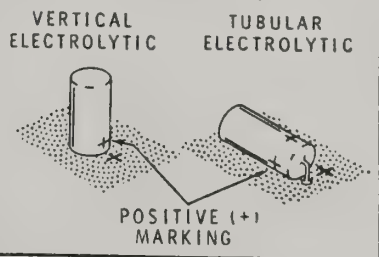


The parts installed in this Pictorial are in this area of the circuit board.



CONTINUE

NOTE: When you install electrolytic capacitors, always match the positive (+) mark on the capacitor with the positive (+) mark on the circuit board.



( ) 25 μF electrolytic.

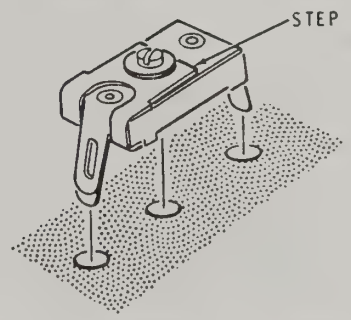
( ) .68 μF polystyrene.

( ) .1 μF Myar.

( ) .05 μF ceramic.

( ) 2 μF electrolytic.

( ) 8-60 pF mica trimmer (#31-52). Position the step as shown. Solder the tabs to the foil.



( ) 8-60 pF mica trimmer (#31-52).

( ) 8-60 pF mica trimmer (#31-52).

( ) 180 pF mica.

( ) 40 meter output coil (#40-1609).

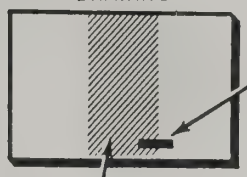
( ) 40 meter output coil (#40-1609).

( ) 20 meter output coil (#40-1610).

( ) Solder the leads to the foil and cut off the excess lead lengths.

PICTORIAL 1-5

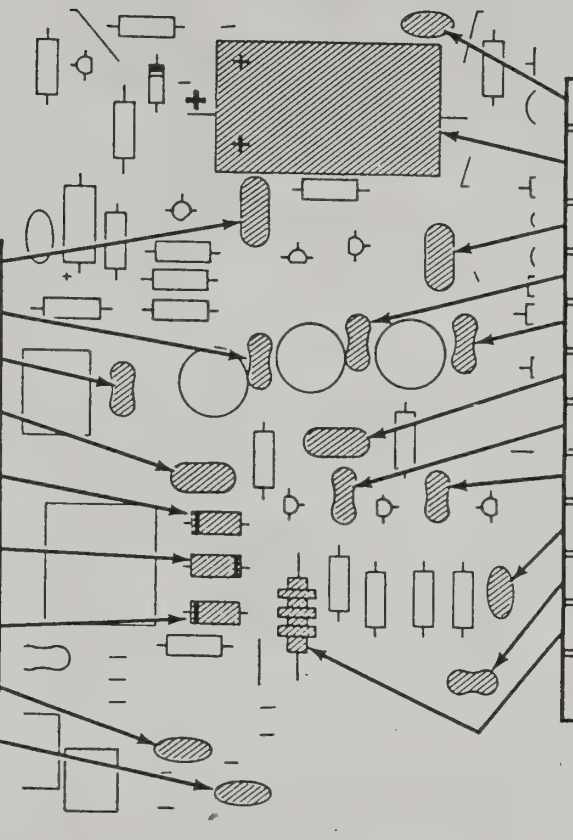
IDENTIFICATION DRAWING



The parts installed in this Pictorial are in this area of the circuit board.

START

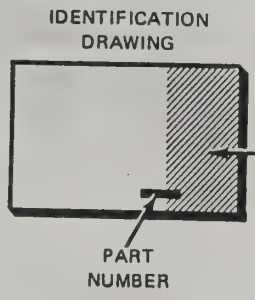
- (✓) .1 µF Mylar.
- (✓) 36 pF mica.
- (✓) 180 pF mica.
- (✓) .1 µF Mylar.
- (✓) 1000 pF polystyrene. Align the colored end with the band.
- (✓) 1200 pF polystryene. Align the colored end with the band.
- (✓) 1000 pF polystyrene. Align the colored end with the band.
- (✓) .05 µF ceramic.
- (✓) 33 pF ceramic.
- (✓) Solder the leads to the foil and cut off the excess lead lengths.



CONTINUE

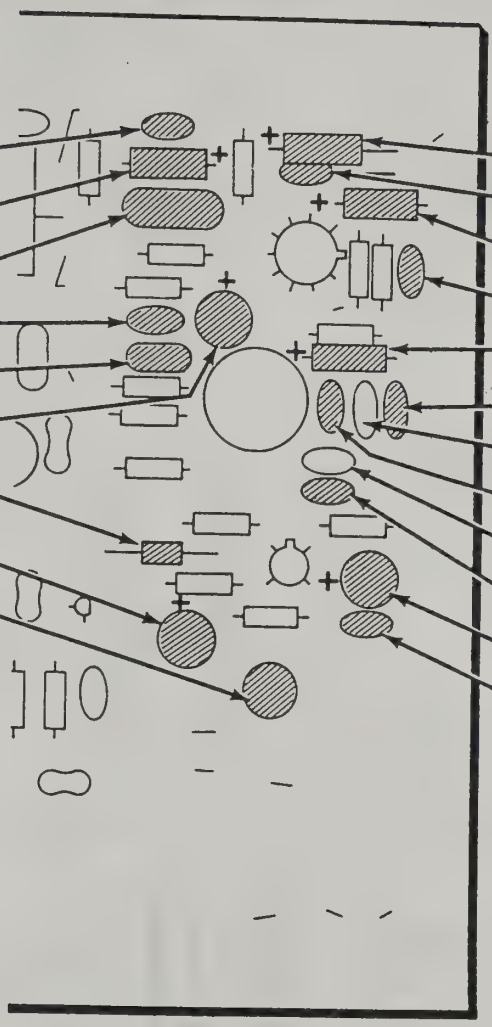
- (✓) .05 µF ceramic.
- (✓) 2000 µF electrolytic. Position the positive (+) end as shown.
- (✓) .1 µF Mylar.
- (✓) 100 pF mica.
- (✓) 150 pF mica.
- (✓) .1 µF Mylar.
- (✓) 24 pF mica.
- (✓) 47 pF mica.
- (✓) .05 µF ceramic.
- (✓) 24 pF mica.
- (✓) 350 µH RF choke (#45-82).
- (✓) Solder the leads to the foil and cut off the excess lead lengths.

PICTORIAL 1-6



START

- ( ) .05 µF ceramic.
- ( ) 2 µF electrolytic. Position the positive (+) lead as shown.
- ( ) .47 µF Mylar.
- ( ) .01 µF ceramic.
- ( ) .1 µF Mylar.
- ( ) 100 µF electrolytic.
- ( ) 1.5 pF phenolic (brown-green-white).
- ( ) 100 µF electrolytic.
- ( ) Receiver antenna coil (#40-1624).
- ( ) Solder the leads to the foil and cut off the excess lead lengths.



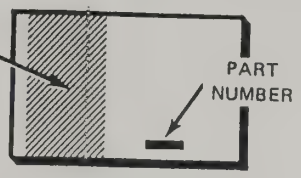
CONTINUE

- ( ) 2 µF electrolytic.
- ( ) .01 µF ceramic.
- ( ) 2 µF electrolytic.
- ( ) .01 µF ceramic.
- ( ) 2 µF electrolytic.
- ( ) .22 µF Mylar.*
- Remains unfilled.*
- ( ) .01 µF ceramic.
- Remains unfilled.*
- ( ) .22 µF Mylar.*
- ( ) 100 µF electrolytic.
- ( ) .05 µF ceramic.
- ( ) Solder the leads to the foil and cut off the excess lead lengths.

*Disregard the ".01" printed on the circuit board at this location.

PICTORIAL 1-7

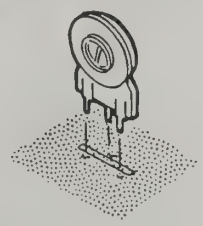
The parts installed in this Pictorial are in this area of the circuit board.



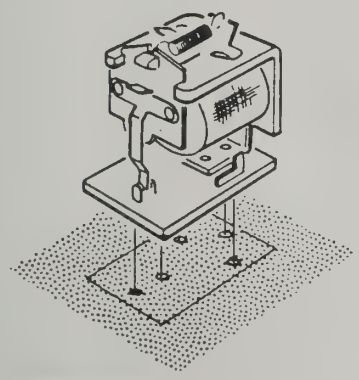
START

NOTE: In the following steps, solder the pins to the foil as you install each part.

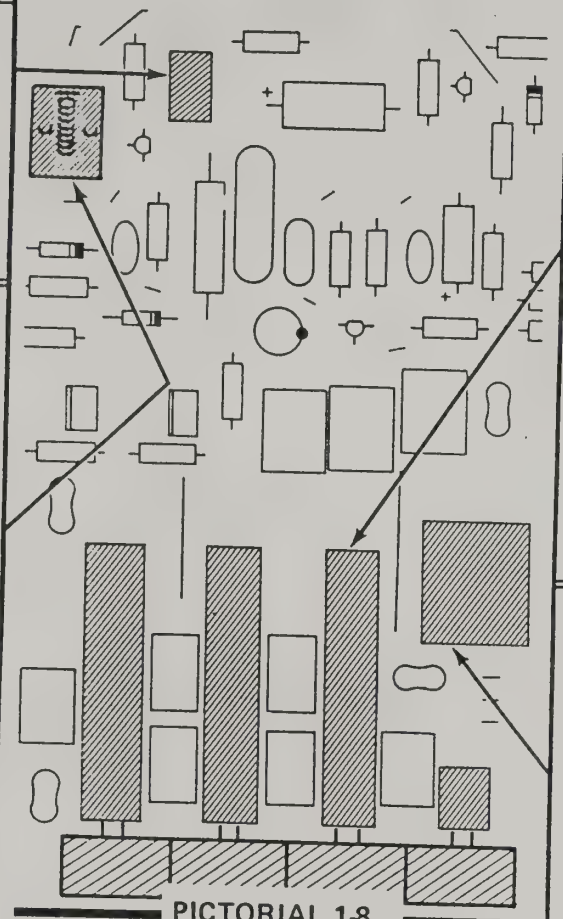
(✓) 50 kΩ control (#10-222).



(✓) Relay #69-47.



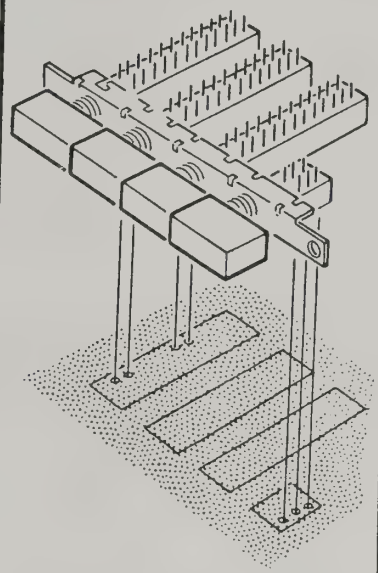
(✓) Locate the switch assembly and position it as shown in Detail 1-8A. Be sure the small switch is at the left end. Then carefully cut off the indicated pins as close to the switches as possible.



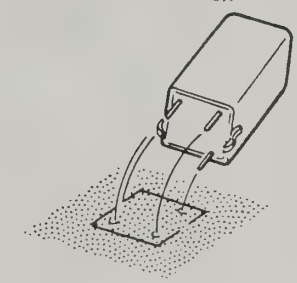
PICTORIAL 1-8

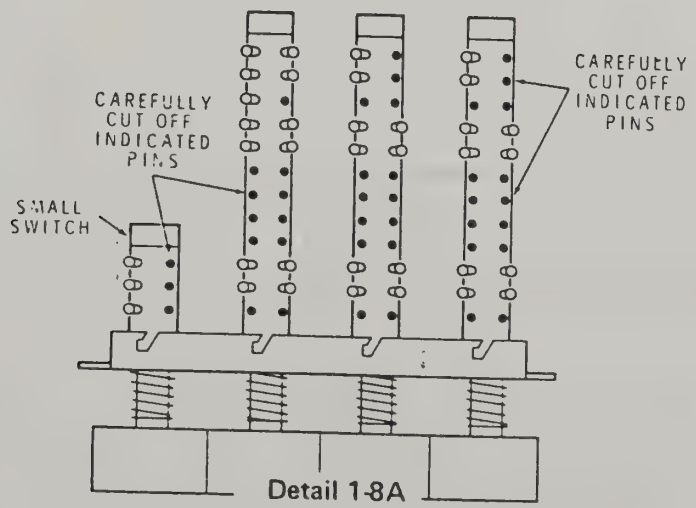
CONTINUE

(✓) Turn the switch assembly over and align the remaining pins with their respective holes in the circuit board. Press the switch assembly tight against the circuit board and solder all 36 pins to the foil.



(✓) VFO coil (#40-1612).

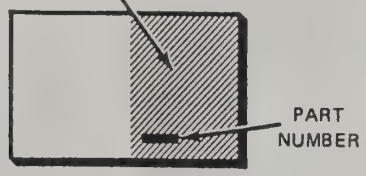




Detail 1-8A

IDENTIFICATION
DRAWING

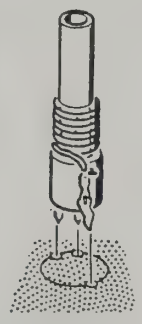
The parts installed in this Pictorial are in this area of the circuit board.



START

NOTE: In the following steps, solder the pins to the foil as you install each part.

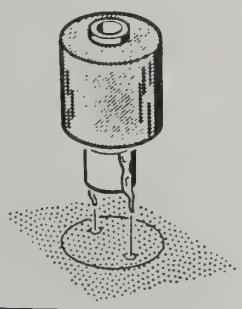
( ) 40 meter doubler coil (#40-1620).



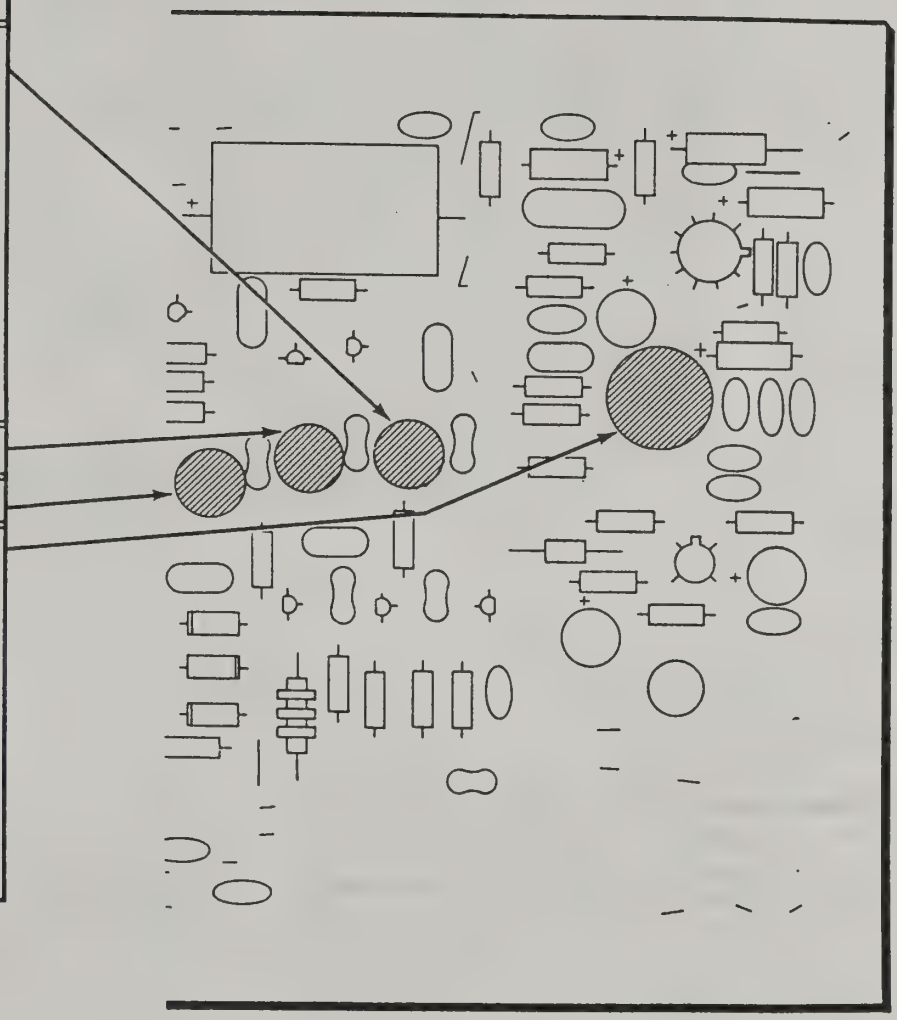
( ) 20 meter doubler coil (#40-1621).

( ) 15 meter tripler coil (#40-1622).

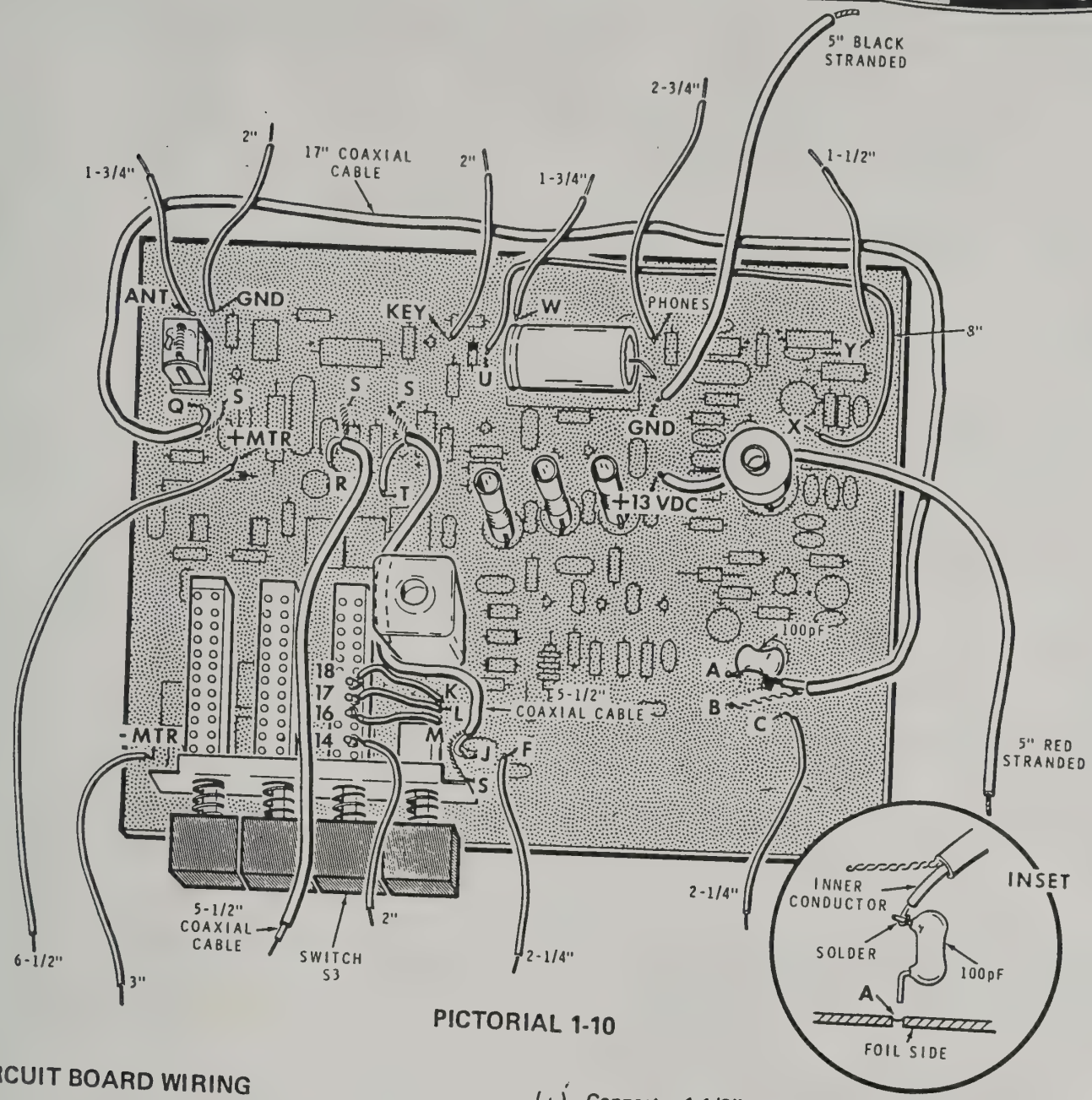
( ) Audio filter coil (#40-1619).



FINISH



PICTORIAL 1-9



PICTORIAL 1-10

CIRCUIT BOARD WIRING

NOTE: When wiring this kit, you will be instructed to prepare the lengths of hookup wire ahead of time, as in the next step. To prepare a wire, cut it to the indicated length and remove 1/4" of insulation from each end. The wires are listed in the order in which they will be used.

( ) Prepare the following lengths of green hookup wire.

1-1/2"	2"
1-1/2"	7"
1-1/2"	

Refer to Pictorial 1-10 for the following steps.

( ) Connect a 1-1/2" green wire from pin 18 of switch S3 (S-1) to hole K in the circuit board (S-1).

( ) Connect a 1-1/2" green wire from pin 17 of switch S3 (S-1) to hole L in the circuit board (S-1).

( ) Connect a 1-1/2" green wire from pin 16 of switch S3 (S-1) to hole M in the circuit board (S-1).

( ) Connect one end of a 2" green wire to pin 14 of switch S3 (S-1). The free end of the wire will be connected later.

( ) Connect a 7" green wire between holes U (S-1) and X (S-1) in the circuit board. Position the wires as shown.

( ) Prepare the following lengths of green hookup wire.

1-3/4"	2-3/4"	2-1/4"
2"	1-1/2"	3"
2"	2-1/4"	6-1/2"
1-3/4"		

Connect one end of each prepared wire to the indicated circuit board hole. The free end of each wire will be connected later.

( ) 1-3/4" wire to hole ANT (S-1).

( ) 2" wire to hole GND (S-1).

( ) 2" wire to hole KEY (S-1).

( ) 1-3/4" wire to hole W (S-1).

( ) 2-3/4" wire to hole PHONES (S-1).

( ) 1-1/2" wire to hole Y (S-1).

( ) 2-1/4" wire to hole C (S-1).

( ) 2-1/4" wire to hole F (S-1).

( ) 3" wire to hole -MTR (S-1).

( ) 6-1/2" wire to hole +MTR (S-1).

NOTE: When you prepare stranded wire, remove 1/4" of insulation from each end of the indicated length of wire of the specified color. Then melt a small amount of solder on the bare wire ends to hold the small wire strands together.

( ) Prepare the following lengths of wire.

5" red stranded
5" black stranded

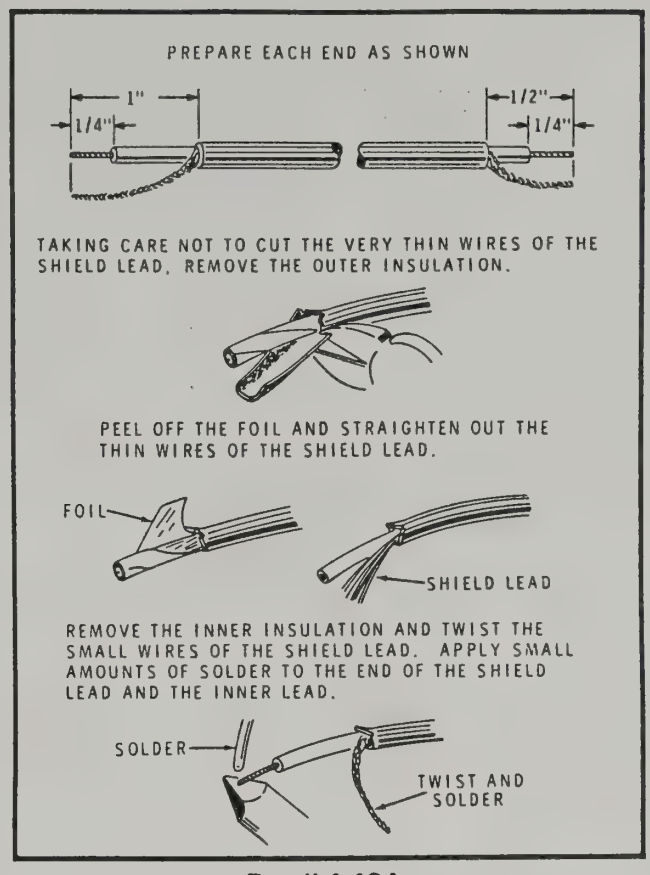
NOTE: In the following steps, install each wire in the indicated circuit board hole.

( ) Connect one end of the 5" red stranded wire to hole +13 VDC (S-1). The free end will be connected later.

( ) Connect one end of the 5" black stranded wire to hole GND (S-1). The free end will be connected later.

( ) Refer to Detail 1-10A and prepare the ends of a 17" length of coaxial cable.

( ) At the end of this cable with the longer inner lead, connect the inner lead to hole Q (S-1) and the shield lead to hole S (S-1).



Detail 1-10A

( ) At its free end, twist the wires of the inner conductor around one of the leads of a 100 pF mica capacitor as shown in the inset drawing. Solder this connection and cut off the excess lead length.

( ) Position the coaxial lead as shown and then connect the free lead of the mica capacitor to hole A (S-1) and the shield lead to hole B (S-1).

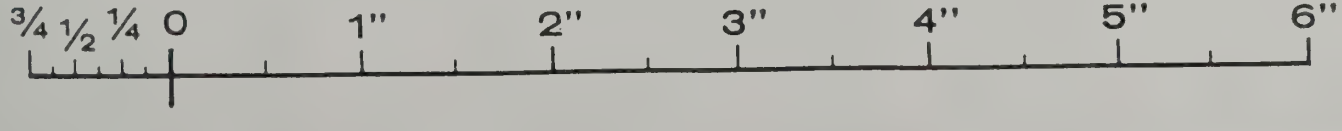
connect the inner lead to hole T (S-1) and the shield lead to hole S (S-1).

( ) At the other end of this cable, connect the inner lead to hole J (S-1) and the shield lead to hole S (S-1). Position this cable as shown.

( ) Refer to Detail 1-10A and prepare the ends of a 5-1/2" length of shielded cable.

( ) At the end of this cable with the longer inner lead, connect the inner lead to hole R (S-1) and the shield lead to hole S (S-1).

( ) At the other end of this cable, cut off the shield lead even with the outer insulation. The free end of this cable will be connected later.



CIRCUIT BOARD CHECKOUT

CAUTION: It is important that you complete the following checkout procedure for the circuit board. Carefully inspect both the component and foil side of the circuit board for the following most commonly made errors. Consult the "Kit Builders Guide," "Step-by-Step Assembly," and the "Circuit Board X-Ray Views" to remedy a particular problem.

1. Unsoldered connections.
2. "Cold" solder connections.
3. Solder bridges between foil patterns.
4. Protruding leads which could touch together.
5. Check electrolytic capacitors for the correct position of the positive (+) ends.
6. Be sure the banded ends of the diodes are positioned correctly.
7. Check transistors for the proper type and installation.
8. Check the integrated circuit for proper installation.

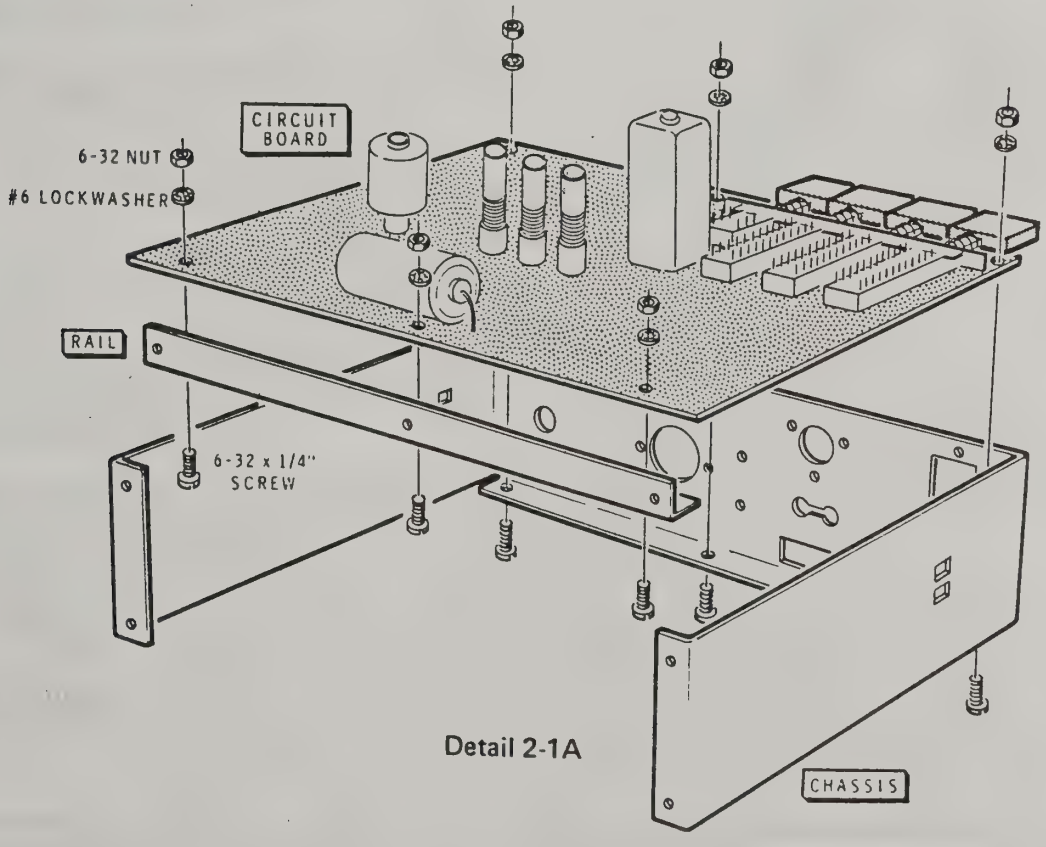
CHASSIS ASSEMBLY AND WIRING

Refer to Detail 2-1A for the following steps. NOTE: When hardware is called for in a step, only the screw size will be given. For instance, if "6-32 x 1/4" hardware" is called for, it means that a 6-32 x 1/4" screw, one or more #6 lockwashers, and a 6-32 nut should be used at each mounting hole. The Detail referred to in the step will show the proper number of lockwashers to use. Use the plastic nut starter supplied with this kit to hold and start 6-32 and 4-40 nuts on screws.

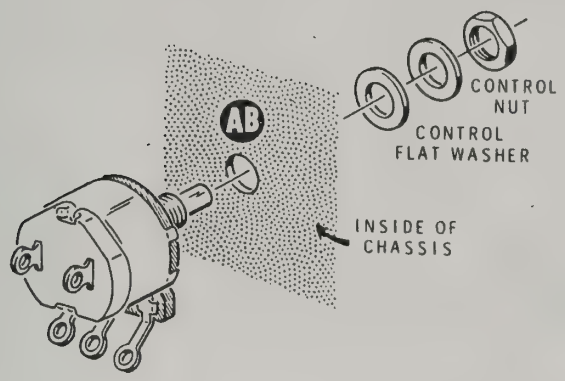
(√) Mount the rail to the indicated edge of the circuit board with 6-32 x 1/4" hardware. Tighten the hardware only finger tight at this time.

(√) Mount the circuit board to the chassis with 6-32 x 1/4" hardware in the holes along the other edge of the circuit board. Tighten the hardware only finger tight at this time.

Refer to Pictorial 2-1 (fold-out from Page 23) for the following steps.



Detail 2-1A



Detail 2-1B

( ) Refer to Detail 2-1B and mount the 10 kΩ control with switch (#19-95) at location AB on the chassis. Use two control flat washers and a control nut.

NOTE: The bare wire called for in some of the following steps is obtained by removing all the insulation from the specified length of green hookup wire.

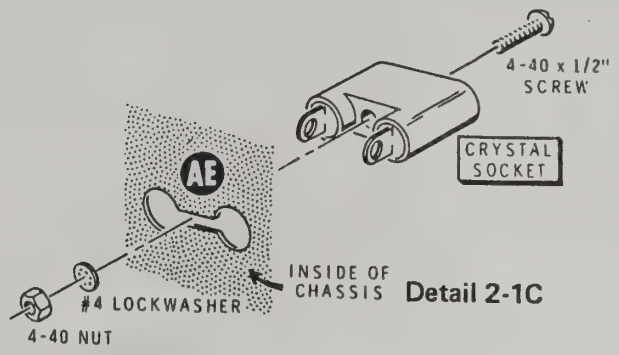
( ) Connect a 1-1/4" length of bare wire from lug 1 of control AB (S-1) to hole E in the circuit board (S-1).

( ) Connect a 1-1/2" length of bare wire from lug 2 of control AB (S-1) to hole D in the circuit board (S-1).

( ) Connect a 1-1/2" length of bare wire from lug 3 of control AB (S-1) to hole S in the circuit board (S-1).

( ) Prepare a 7" length of red stranded wire. Connect one end of this wire to lug 4 on control AB (S-1). The free end of this wire will be connected later.

( ) Connect the free end of the red stranded wire coming from hole +13 VDC in the circuit board to lug 5 of control AB (S-1). Position the wire as shown.

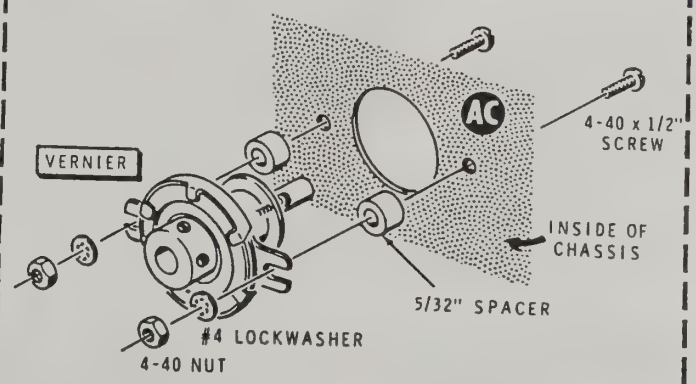


Detail 2-1C

( ) Refer to Detail 2-1C and install the crystal socket at location AE of the chassis with 4-40 x 1/2" hardware.

( ) Connect the free end of the green wire coming from hole F in the circuit board to lug 1 of crystal socket AE (S-1).

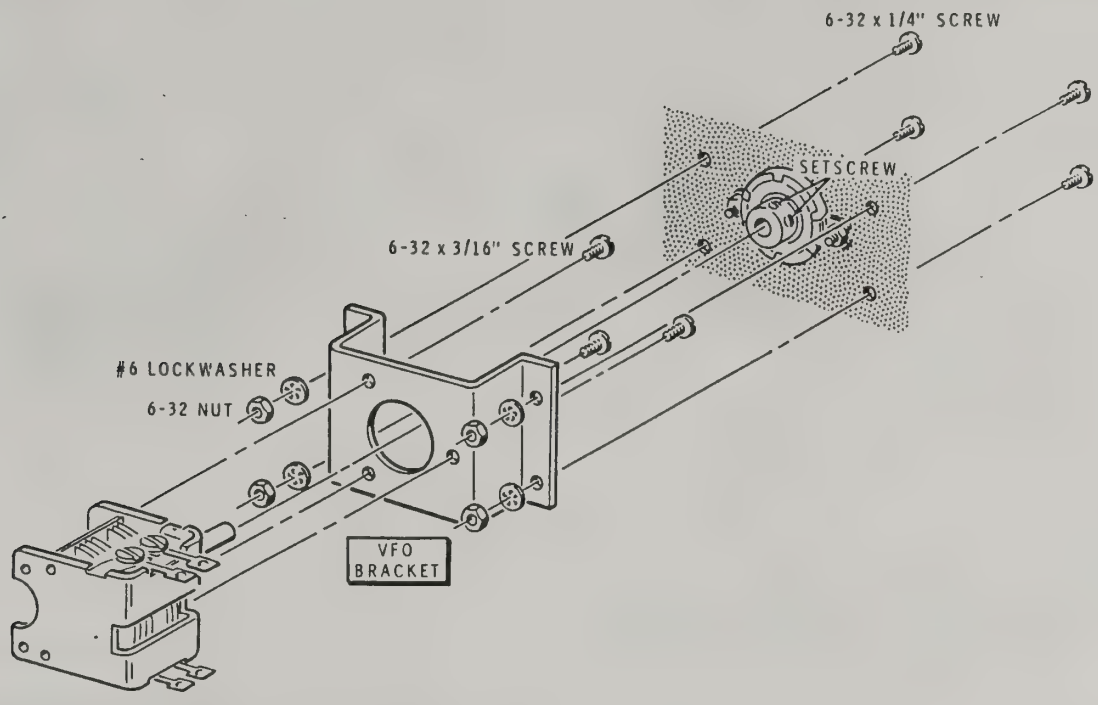
( ) Connect the inner lead at the free end of the coaxial cable coming from holes R and S in the circuit board to lug 2 of crystal socket AE (S-1). The shield at this end of the cable was removed earlier as it is not used.



Detail 2-1D

( ) Refer to Detail 2-1D and install the vernier at AC on the chassis. Use 4-40 x 1/2" hardware and two spacers. Tighten the hardware only finger tight at this time.

assembly.



Detail 2-1E

( ) Mount the 2-section variable capacitor (#26-140) on the VFO bracket with three 6-32 x 3/16" screws. Be sure to position the capacitor properly.

( ) Fit the shaft of the 2-section variable capacitor into the vernier at AC on the chassis. Now secure the VFO bracket to the chassis with 6-32 x 1/4" hardware. NOTE: It may be necessary to loosen the vernier setscrews slightly so the capacitor shaft will fit into the vernier.

( ) Now tighten the hardware that mounts the vernier to the chassis.

( ) Connect a 1-1/2" bare wire from lug 3 of variable capacitor AC (S-1) to hole H in the circuit board (S-1).

( ) Connect a 1-1/2" bare wire from lug 4 of variable capacitor AC (S-1) to hole G in the circuit board (S-1).

( ) Refer to Detail 2-1F and mount a 1-section variable capacitor (#26-139) at location AD on the chassis with three 6-32 x 3/16" screws.

( ) In the same manner, install another 1-section variable capacitor (#26-139) at AA on the chassis. Use 6-32 x 3/16" screws.

( ) Connect the free end of the green wire coming from hole C in the circuit board to lug 4 of variable capacitor AA (S-1).

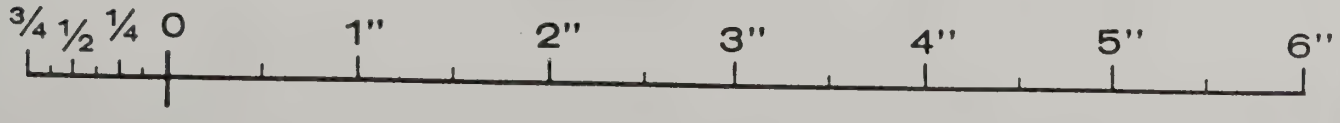
( ) Connect the free end of the green wire coming from pin 14 of switch S3 to lug 4 of variable capacitor AD (S-1).

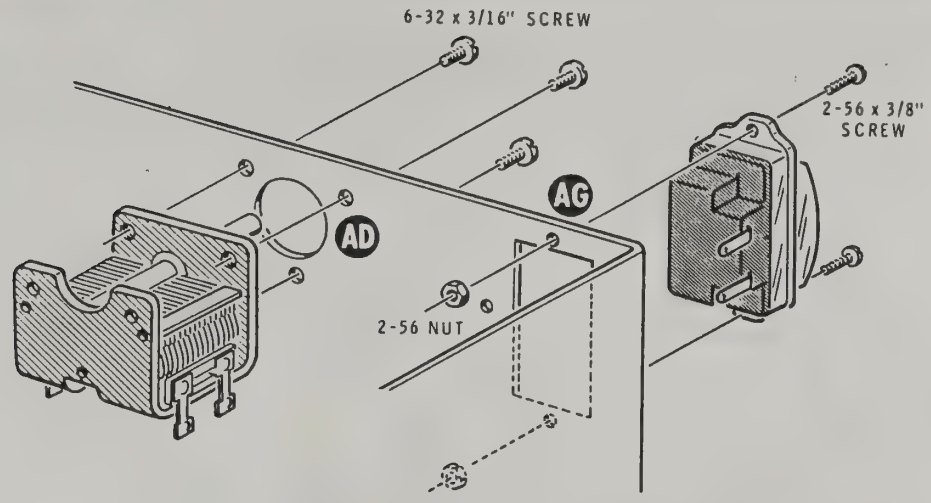
( ) Locate the meter and remove any fine wire that is wrapped around its lugs.

( ) Refer to Detail 2-1F and mount the meter at AG on the chassis with 2-56 x 3/8" screws and 2-56 nuts. Position the meter as shown. Be very careful not to overtighten the hardware, as you may break the meter.

( ) Connect the free end of the green wire coming from hole –MTR in the circuit board to lug 2 of the meter at AG (S-1).

( ) Connect the free end of the green wire coming from hole +MTR in the circuit board to lug 1 of meter AG (S-1).





Detail 2-1F

( ) Set the chassis aside temporarily.

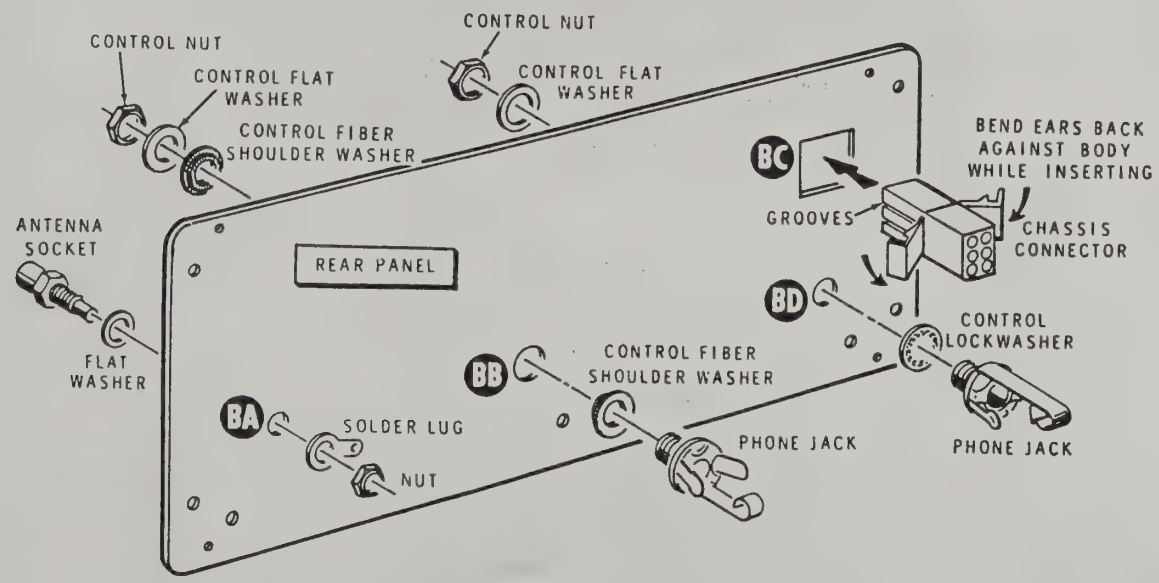
Refer to Pictorial 2-2 for the following steps.

( ) Install the antenna socket at BA on the rear panel. Use the flat washer, solder lug, and nut furnished with the socket. Bend the solder lug up slightly. Be careful not to overtighten the hardware, as you may snap off the socket.

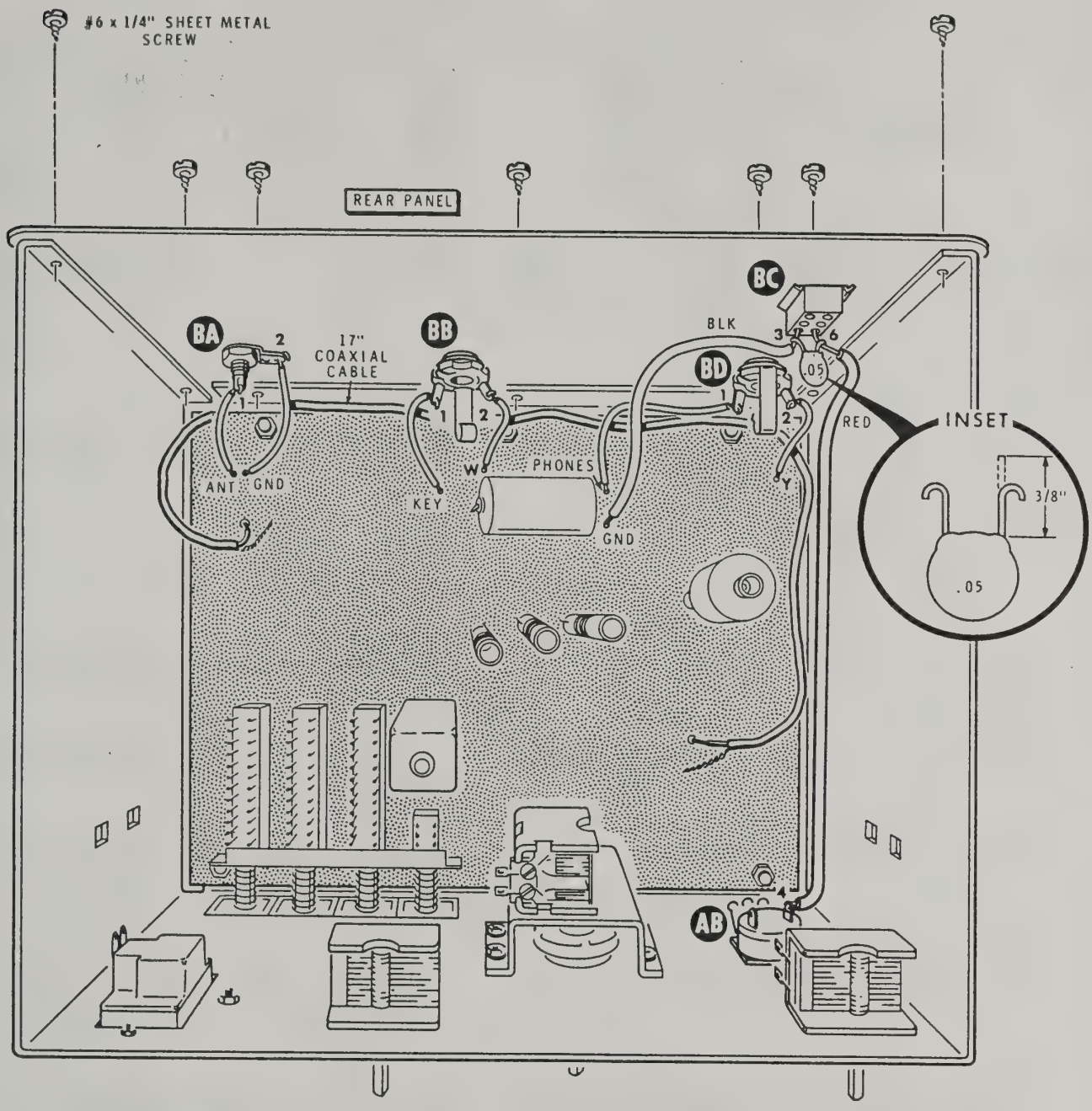
( ) Mount a phone jack at hole BB in the rear panel. Use two control fiber shoulder washers, a control flat washer, and a control nut. Be sure the small diameter portion of each fiber shoulder washer fits into the hole.

( ) Install a phone jack in hole BD of the read panel with a control lockwasher, control flat washer, and a control nut.

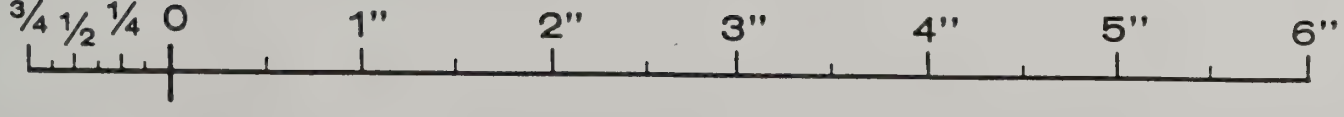
( ) Install the chassis connector in hole BC of the rear panel. Note the position of the grooves in the connector.



PICTORIAL 2-2



PICTORIAL 2-3



Refer to Pictorial 2-3 for the following steps.

( ) Mount the rear panel on the chassis with seven #6 x 1/4" sheet metal screws. Be sure not to pinch any wires between the metal parts and do not cut the insulation of any wires with the screws.

( ) Tighten the hardware that secures the rail to the circuit board.

( ) Tighten the hardware that secures the circuit board to the rail and the chassis.

( ) Route the 17" coaxial cable along the edge of the circuit board.

Connect the free ends of the wires coming from the circuit board to the rear panel parts as follows:

( ) Green wire from hole ANT to lug 1 of antenna socket BA (S-1).

( ) Green wire from hole GND to lug 2 of antenna socket BA (S-1).

( ) Green wire from hole KEY to lug 1 of phone jack BB (S-1).

( ) Green wire from hole W to lug 2 of phone jack BB (S-1).

( ) Green wire from hole PHONES to lug 1 of phone jack BD (S-1).

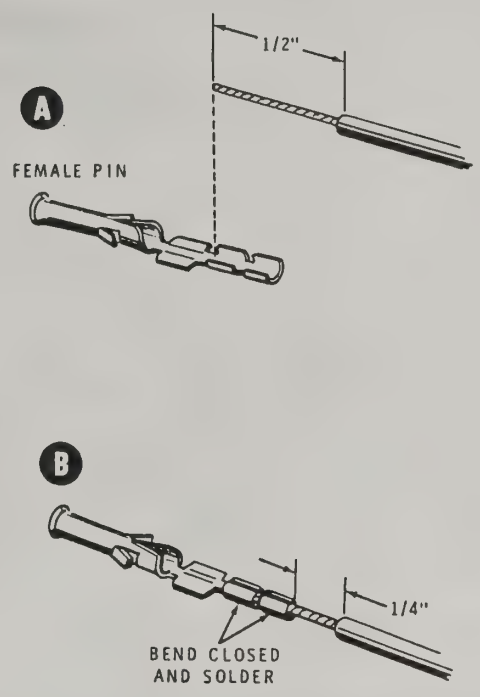
( ) Green wire from hole Y to lug 2 of phone jack BD (S-1).

( ) Remove an additional 1/4" of insulation from the free end of the black wire coming from hole GND in the circuit board.

( ) Refer to Detail 2-3A and install a female pin on the end of this wire as shown. When soldering, be very careful not to get solder in the pin.

( ) After the pin has cooled, push it into hole 3 of the chassis connector BC.

( ) Remove an additional 1/4" of insulation from the free end of the red wire coming from lug 4 of control AB.



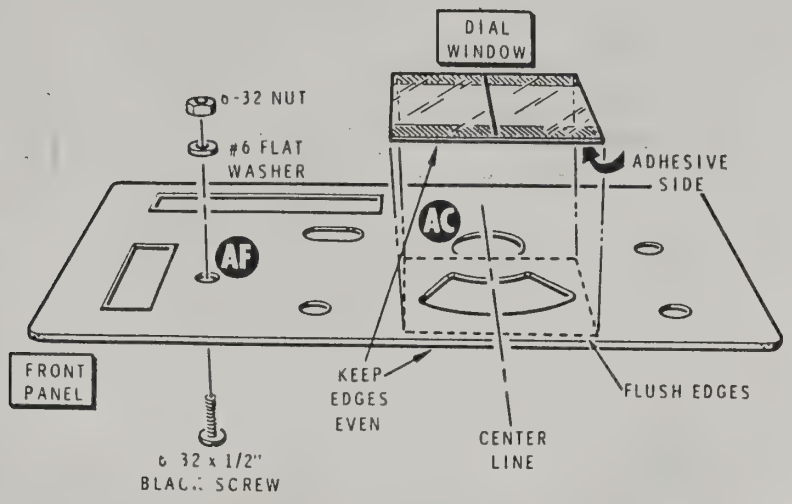
Detail 2-3A

( ) Install a female pin on the red wire in the same manner as before.

( ) Push this pin into hole 6 of the chassis connector at BC.

( ) Refer to the inset drawing in Pictorial 2-3 and cut both leads of a .05 μF ceramic capacitor to 3/8". Then bend a hook in each lead as shown.

( ) Hook the capacitor leads over the bared portion of the wires extending from holes 3 and 6 of chassis connector BC. Now solder the capacitor leads to the wires. Be careful not to overheat the capacitor or the chassis connector.



PICTORIAL 2-4

FRONT PANEL MOUNTING

Refer to Pictorial 2-4 for the following steps.

( ) Draw a pencil line through the center of hole AC on the inside of the front panel.

( ) Remove the lengths of tape from the dial window (#446-602-1). Position the black line of the dial window over the pencil line on the front panel. Position the edge of the dial window even with the edge of the front panel as shown. Then press the dial window in place.

( ) Install a 6-32 x 1/2" black screw, a #6 flat washer, and a 6-32 nut at hole AF in the front panel.

Refer to Pictorial 2-5 for the following steps.

( ) Turn the vernier until the setscrews are in the positions shown in Detail 2-5A.

( ) Temporarily remove the two small screws from the front of the vernier at AC.

( ) Mount the dial on the vernier with these two small screws. Be sure the dial is positioned as shown.

( ) Mount the front panel on the chassis with a #6 lockwasher and a 6-32 nut at AF, and a control nut at AB.

( ) Turn the shafts at AA, AB, and AD fully counterclockwise.

( ) Install small knobs at AA, AB, and AD. Position their pointers as shown and tighten the setscrews.

( ) Install a large knob in the shaft at AC and tighten the setscrew.

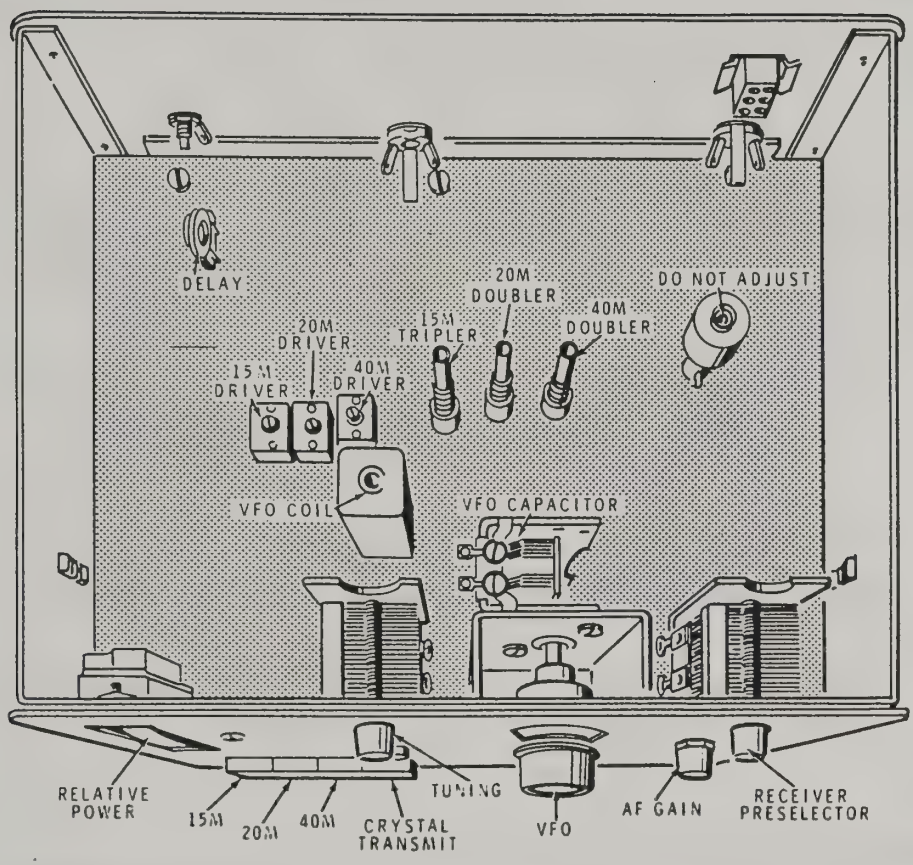
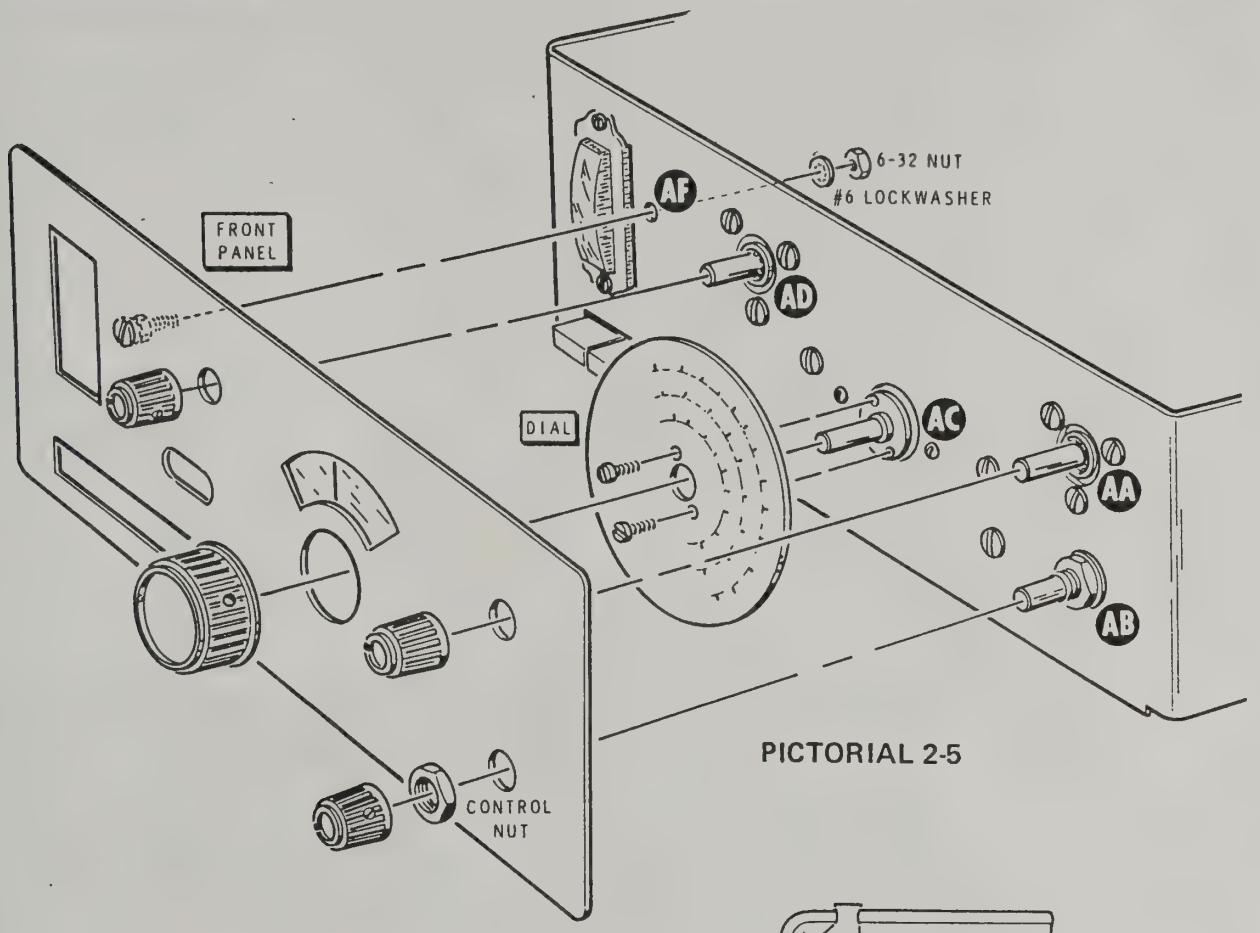

DELAY
20M DRIVER
15M DRIVER
40M DRIVER
15M TRIPLER
20M DOUBLER
40M DOUBLER
DO NOT ADJUST
VFO COIL
VFO CAPACITOR
RELATIVE POWER
15M
20M
40M
CRYSTAL TRANSMIT
TUNING
VFO
AF GAIN
RECEIVER PRESELECTOR

Figure 1-1



PICTORIAL 2-5

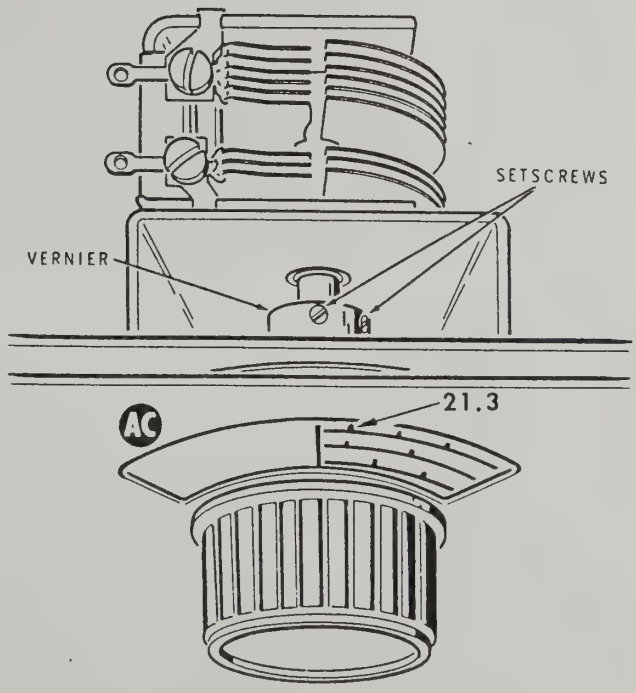
Refer to Detail 2-5A for the following steps.

(1) Rotate the large knob clockwise until the end of the dial (near 21.3) is lined up with the line on the dial window as shown.

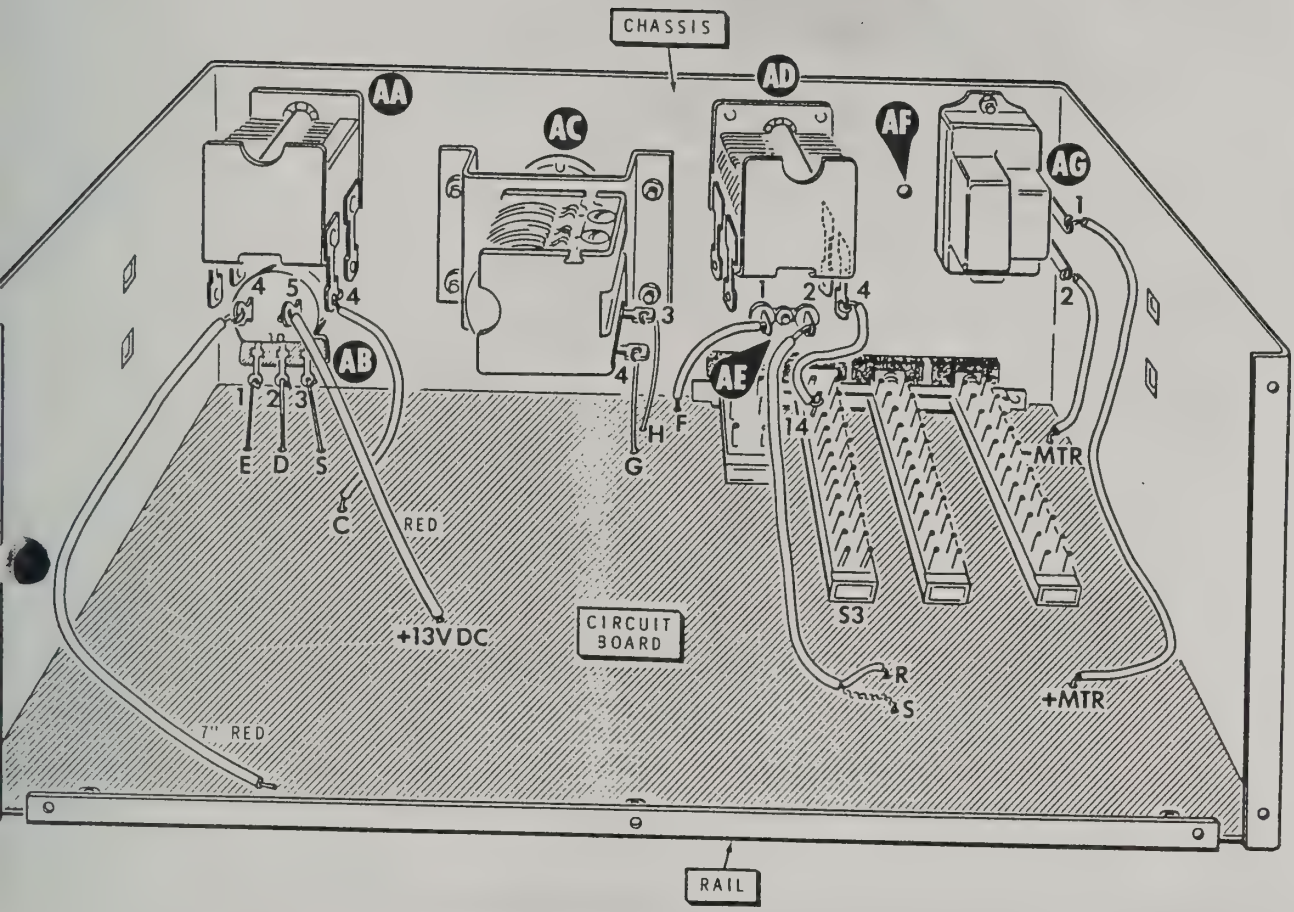
(2) Carefully open the plates of the variable capacitor at AC until the plates are fully open.

(3) Tighten the two setscrews of the vernier.

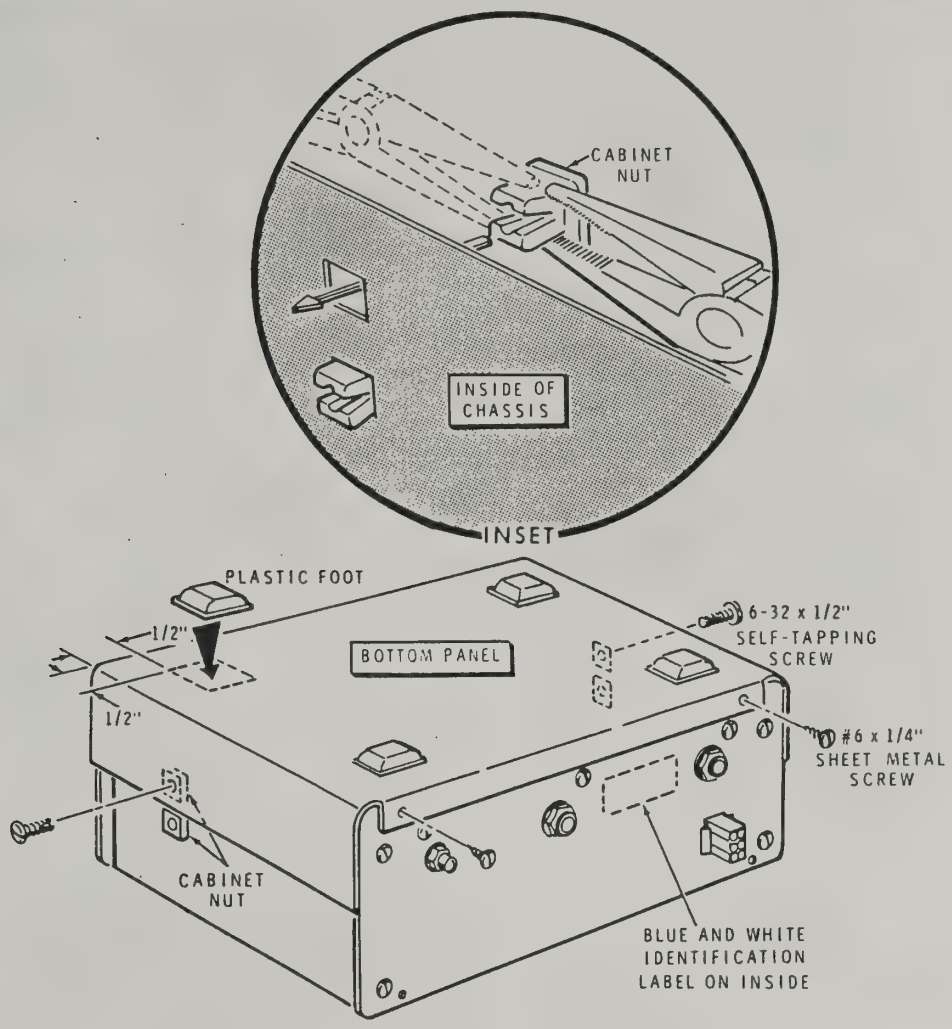
This completes the wiring and assembly of the kit. Check to see that all connections are soldered and that all excess lead lengths are cut off on the foil side of the circuit board. Shake out any wire clippings that may be lodged between the components.



Detail 2-5A



PICTORIAL 2-1



PICTORIAL 2-6

Refer to Pictorial 2-6 for the following steps.

( ) Press the four cabinet nuts into the square holes in the sides of the chassis. Use long-nose pliers to squeeze the tabs together.

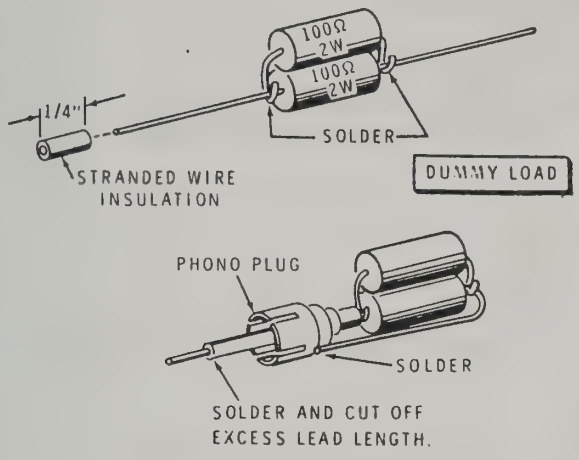
( ) Position the chassis upside down on your work area.

( ) Mount a cabinet shell on the bottom of the chassis. Install 6-32 x 1/2" self-tapping screws into the cabinet nuts and #6 x 1/4" sheet metal screws into the rear panel.

( ) Remove the protective paper from four feet and press them into place on the cabinet shell.

NOTE: The blue and white label shows the Model Number and Production Series Number of your kit. Refer to these numbers in any communications with the Heath Company; this assures you that you will receive the most complete and up-to-date information in return.

( ) Carefully peel the backing paper from the blue and white identification label and press the label on the rear panel at the location shown.



PICTORIAL 2-7

Refer to Pictorial 2-7 for the following steps.

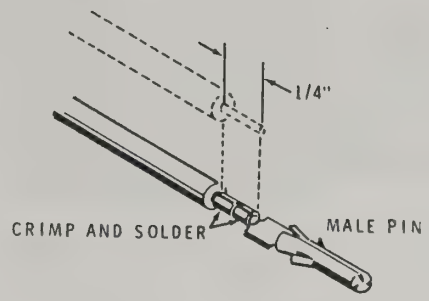
( ) Locate the two 100 Ω, 2-watt (brown-black-brown) resistors. Bend the leads of one resistor around the leads of the other resistor as shown. Solder both connections and cut off the indicated resistor leads.

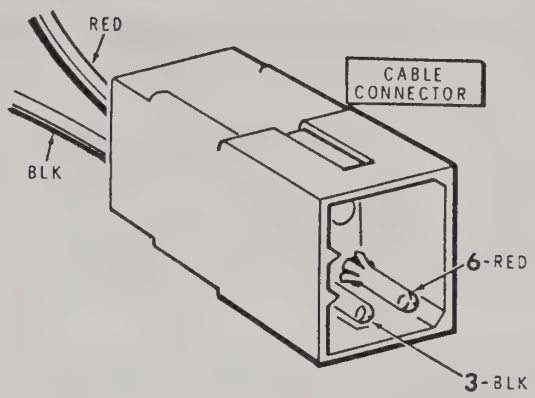
( ) Place a 1/4" length of black insulation (removed from the black stranded wire) onto one of the remaining resistor leads.

( ) Insert this resistor lead into the pin of the antenna plug. Solder the connection and cut off the excess resistor lead. NOTE: Apply heat to the tip of the pin only long enough for the solder to be drawn up into the pin by capillary action. Cut off the excess wire from the tip of the pin.

( ) Bend and solder the remaining resistor lead to the shell of the antenna plug.

This is a 50 Ω dummy load that will be used later.





PICTORIAL 2-8

Refer to Pictorial 2-8 for the following steps.

( ) Prepare the one end of the black stranded and red stranded wires.

( ) Install a male connector on the prepared end of each wire.

( ) Push the connector on the black wire into hole #3 of the cable connector.

( ) Push the connector on the red wire into hole #6 of the cable connector.

This assembly can be used as a power cable for your kit.

INITIAL TESTS

Refer to Figure 1-1 (fold-out from Page 24) for the following steps.

( ) Rotate all the controls fully counterclockwise.

( ) Press in the 40M pushbutton.

( ) Be sure the CRYSTAL TRANSMIT pushbutton is in its out position.

( ) Connect the 50 Ω dummy load to the ANTENNA phono socket on the rear panel.

( ) Connect a pair of headphones, preferably 2000 Ω, to the HEADPHONES jack on the rear panel.

NOTE: The Heathkit Electronic Keyer, Model HD-10, can be used with this Transceiver. Otherwise be sure that your keyer or key has a phone plug that mates with the KEY jack on the Transceiver.

( ) Connect your key to the Transceiver KEY jack.

( ) Connect an appropriate power supply, such as the Heathkit Model HWA-7-1, to the POWER connector on the rear panel. CAUTION: Be sure to observe the correct polarity or the transistors will be permanently damaged.

NOTE: If you do not get the required results in the following steps, turn OFF the Transceiver and refer to the "In Case of Difficulty" section on Page 30.

( ) Turn on the power supply and then turn on the Transceiver. Rotate the AF GAIN control to the 12 o'clock position. You should hear noise in the headphones.

( ) Slowly rotate the RECEIVER PRESELECTOR knob. As the knob pointer is moved through the 40 meter segment, a slight change in the noise should be heard. As the knob is rotated further, at least two more similar changes should be heard. One in the 20 and one in the 15 meter segment. This change in the noise will be referred to as a peak.

( ) Tighten the three driver trimmer capacitors until they are just snug.

( ) Loosen the 15M DRIVER capacitor 3/4 turn from its snug position.

( ) Loosen the 20M DRIVER capacitor 1/8 turn from its snug position.

( ) Loosen the 40M DRIVER capacitor 1/4 turn from its snug position.

( ) Key the Transceiver. The relay should energize and a sidetone should be heard in the headphones. Release the key.

( ) Key the Transceiver. Rotate the TUNING knob for a peak indication on the relative power meter. Release the key.

( ) Press in the 20M pushbutton.

( ) Key the Transceiver. Rotate the TUNING knob for a * peak indication on the relative power meter and then release the key.

( ) Press in the 15M pushbutton.

( ) Key the Transceiver. Rotate the TUNING knob for a * peak indication on the relative power meter and then release the key.

This completes the "Initial Tests." Proceed to the "Alignment" section of the Manual.

*NOTE: It is possible to obtain two peak indications on both the 20 meter band and the 15 meter band. Tune only for the following peaks and disregard the other peak on that band.

20M: Between 1 and 2 on the tuning dial.
15M: Between 2 and 3 on the tuning dial.

ALIGNMENT

NOTE: Transceiver alignment requires the use of a calibrated receiver, such as a Heathkit Model SB-303 or equivalent, capable of receiving 7.0 MHz, 7.2 MHz, 14.0 MHz, and 14.2 MHz.

VFO ALIGNMENT

( ) Turn on the calibrated receiver and allow it to warm up.

( ) Be sure the 50 Ω dummy load, headphones, key, and power supply are connected to the Transceiver.

( ) Press in the 40M pushbutton.

( ) The CRYSTAL TRANSMIT pushbutton should be in its out position.

( ) Rotate the TUNING knob fully counterclockwise.

( ) Rotate the RECEIVER PRESELECTOR knob fully counterclockwise.

( ) Rotate the AF GAIN – OFF control to the twelve o'clock position.

( ) Set the Transceiver VFO to 7.1 MHz.

NOTE: In the following steps, you will zero beat the receiver to its crystal calibrator. Then you will zero beat the calibrated receiver against the Transceiver. Zero beat is a point where the two frequencies being combined (beat against each other) are exactly the same frequency. As zero beat is approached, the tone caused by the two combined frequencies will gradually decrease in pitch and volume until it just stops.

The two frequencies to be zero beat first are the crystal calibrator and receiver frequencies. Then the receiver frequency will be used to zero beat the Transceiver frequency. The end result will be a calibrated Transceiver that has a true frequency nearly identical to the dial frequency.

( ) Tune the calibrated receiver to 7.0 MHz. Then turn on the crystal calibrator and gradually adjust the receiver frequency until the tone decreases in pitch and volume. It may be necessary to increase the RF and AF gain controls. When the tone just stops, zero beat has been reached.

( ) Turn off the crystal calibrator.

( ) Tune the Transceiver VFO to 7.0 MHz.

( ) Refer to Figure 1-1 (fold-out from Page 24) and tighten both trimmers on the VFO capacitor until they are just snug. Then rotate each trimmer 1/2-turn counterclockwise.

( ) Again refer to Figure 1-1 and rotate the top slug in the VFO coil until a zero beat is heard from the calibrated receiver. It may be necessary to turn down the calibrated receiver AF gain control. Use the supplied alignment tool to make the adjustment. Do not rotate the coil slug more than one turn in either direction.

( ) Tune the calibrated receiver to 7.2 MHz.

( ) Tune the Transceiver to 7.2 MHz.

( ) If a zero beat is not heard, rotate the rear trimmer on the VFO capacitor slightly in either direction until a zero beat is reached.

( ) Again tune the calibrated receiver and the Transceiver to 7.0 MHz and check the zero beat. Then recheck the 7.2 MHz position for a zero beat. When no further improvement can be made in the zero beats, proceed to the next step.

( ) Tune and zero beat the calibrated receiver to 14.0 MHz.

( ) Press in the 20M pushbutton on the Transceiver.

( ) Tune the Transceiver main tuning to 14.0 MHz.

( ) Again refer to Figure 1-1 and use the alignment tool to adjust the bottom slug of the VFO coil until a zero beat is heard from the calibrated receiver. This adjustment is rather difficult to accomplish since the zero beat point can be passed over very easily. Carefully rotate the coil slug back-and-forth until the zero beat is reached.

( ) Tune the calibrated receiver to 14.2 MHz.

( ) Tune the Transceiver to 14.2 MHz.

( ) If a zero beat is not heard, rotate the front trimmer on the VFO capacitor slightly in either direction until a zero beat is reached.

( ) Again tune the calibrated receiver and the Transceiver to 14.0 MHz and check the zero beat. Then recheck the 14.2 MHz position for a zero beat. When no further improvements can be made in the zero beats, proceed to the next step.

( ) The calibrated receiver is no longer needed; set it aside.

TRANSMITTER ALIGNMENT

( ) Press in the 40M pushbutton on the Transceiver.

( ) Tune the main tuning to 7.1 MHz.

( ) Key the Transceiver. Rotate the TUNING knob for a peak indication on the relative power meter and release the key.

( ) Key the Transceiver and adjust the 40M DRIVER capacitor for a peak meter indication. Release the key.

( ) Key the Transceiver and adjust the 40M DOUBLER coil for a peak meter indication. Release the key.

( ) Press in the 20M pushbutton.

( ) Set the main tuning to 14.1 MHz.

( ) Key the Transceiver and rotate the TUNING knob for a peak meter indication.* Release the key.

( ) Key the Transceiver and adjust the 20M DRIVER capacitor for a peak meter indication. Release the key.

( ) Key the Transceiver and adjust the 20M DOUBLER coil for a peak meter indication. Release the key.

( ) Press in the 15M pushbutton.

( ) Set the main tuning to 21.15 MHz.

( ) Key the Transceiver and rotate the TUNING knob for a peak meter indication.* Release the key.

( ) Key the Transceiver and adjust the 15M DRIVER capacitor for a peak meter indication. Release the key.

( ) Key the Transceiver and adjust the 15M TRIPLER coil for a peak meter indication. Release the key.

NOTE: This completes the alignment of the Transceiver for VFO operation. If the Transceiver will be used for crystal operation, install your particular crystal and press in the CRYSTAL TRANSMIT pushbutton. Then adjust the DRIVER capacitor for a peak meter indication on the band you have the Transceiver tuned to.

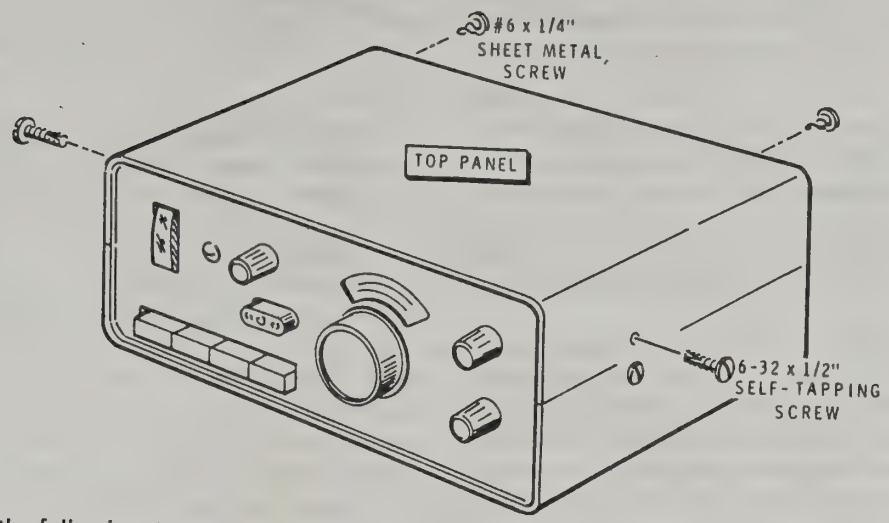
( ) Key the Transceiver and adjust the DELAY control for the desired amount of "delay" that the transmitter "holds in" after the last transmitted character.

( ) Do not attempt to adjust the audio filter coil as it was adjusted at the factory.

This completes the "Alignment" of the Transceiver. Proceed to the "Final Assembly" section of the Manual.

* REFER TO THE NOTE ON P 26

FINAL ASSEMBLY



Refer to Pictorial 2-9 for the following steps.

( ) Position the remaining cabinet shell on the Transceiver as shown.

( ) Mount the cabinet shell to the Transceiver with two #6 x 1/4" sheet metal screws and two 6-32 x 1/2" self-tapping screws.

PICTORIAL 2-9

This completes the assembly of the Transceiver. Proceed to the "Operation" section of the Manual.

OPERATION

The Transceiver is basically a QRP (low power) rig with provisions for crystal control on transmit. As a result, a little patience and experience will greatly improve the operating results. Be sure to read the entire "Operation" section before you use the Transceiver on the air.

TRANSCEIVE OPERATION

The CRYSTAL TRANSMIT pushbutton should be in its out position and no crystal should be installed. This is to prevent excitation of the crystal when it is not actually in the circuit. The following steps indicate the procedure for tuning up and placing the Transceiver on the air.

1. Be sure the 50 Ω dummy load or acceptable antenna, headphones, key, and power supply are connected to the Transceiver.
2. Turn the AF GAIN — OFF control to the 12 o'clock position. Then adjust the control for a comfortable listening level.

3. Press in the pushbutton for the band you intend to operate on.

4. Adjust the main tuning to the portion of the band where you intend to operate.

5. Listen to the headphones and adjust the RECEIVER PRESELECTOR for maximum signal loudness. Be sure it is in the same band segment as the band you are operating on.

6. Key the Transceiver and rotate the TUNING knob for a peak meter indication. Then release the key.

7. The Transceiver is now ready for on-the-air operation. If you used the dummy load for tune-up, it may be necessary to repeak the TUNING knob after your antenna is connected. This is to assure a good electrical match between the antenna and the transmitter.

NOTE: When tuning across the band, always go to the high end of the band first. Then tune down to the low end of the band. This is to assure that you will be on the high side of the zero beat when listening to a signal. Otherwise you may answer a CQ on the low side of zero beat and your transmitting frequency will be approximately 5 kHz low.

CRYSTAL OPERATION

The same procedures apply for crystal operation as for transceive, with one exception. After you install your crystal, be sure the CRYSTAL TRANSMIT pushbutton is pressed in. The required crystal specifications are covered in the "Specifications" section of the Manual.

ANTENNAS

The Transceiver should be used with 50 ohm to 75 ohm antennas having a low VSWR. Lightweight hookup wire dipoles and inverted vee's are sufficient for solid contacts. They can be quickly strung up for camping trips and emergency operation, as well as field day. However, antennas of the beam and quad type will provide a significant improvement in performance, much more so than for medium to high-power rigs.

The "ARRL Antenna Book" is commonly available and includes comprehensive reference work on transmission lines and antennas. Other similar handbooks for the amateur are offered for sale and can often be found in a public library.

OPERATING HINTS

When operating a QRP (low power) rig, your transmitted signal may be below the signal level preferred by most operators. Generally, lower power signals lose out unless a few simple techniques are followed. In many cases, listening for a CQ is more acceptable since your signal then has a greater chance of being copied. A station can be called just after he completes a contact which may also prove successful. Also, be sure that you are on the high side of zero beat when you transmit as described previously.

You may find the Transceiver is susceptible to some microphonics. This is due to the nature of the circuit and should not be a problem in normal operation. Foreign phone and broadcast stations may also be heard when tuning the receiver preselector. The detector stage can become overloaded if the receiver preselector is not peaked properly in the correct band segment. You can use an antenna tuner with the Transceiver to improve the transmitter-to-antenna impedance match and the receiver's selectivity.

Emergency operation is sometimes a necessity and always unexpected. The Transceiver is well suited for these situations if an antenna is available. A power source is usually no problem since any automobile battery or lantern batteries of the appropriate voltage can provide hours of dependable operation. Refer to the "Specifications" section for voltage and current requirements.

IN CASE OF DIFFICULTY

This section of the Manual is divided into two parts: "Visual Checks," and the "Troubleshooting Chart." Begin your search by carefully following the checks listed below. After they are completed, refer to the "Troubleshooting Chart" if necessary.

VISUAL CHECKS

NOTE: The following checks will be most effective if you apply them to one circuit board, or other part of the kit, at a time.

1. About 90% of the kits that are returned for repair do not function properly due to poor connections and soldering. Therefore, many troubles can be eliminated by a careful inspection of connections to make sure they are soldered as described in the "Soldering" section of the "Kit Builders Guide." Resolder any doubtful connections and be sure all the wires are soldered at places where several wires are connected.

2. Check each circuit board to be sure there are no solder bridges between adjacent connections. Remove any

solder bridges by holding a clean soldering iron tip between the two points that are bridged until the excess solder flows down the tip of the soldering iron.

3. Be sure each transistor is in the proper location (correct part number and type number). Be sure that each transistor lead is positioned properly and has a good solder connection to the foil.

4. Check capacitor values carefully. Be sure the proper part is wired into the circuit at each capacitor location. Always check the polarity of electrolytic capacitors to be sure they are installed correctly.

5. Check each resistor carefully. It would be easy, for example, to install a 1000 Ω (brown- black-red) resistor where a 100 kΩ (brown-black-yellow) resistor is called for. A resistor that is discolored, or cracked, or shows any sign of bulging would indicate that it is faulty and should be replaced.

6. Be sure the correct diode is installed at each diode location, and that the banded end is positioned correctly.

7. Recheck the wiring. Trace each lead in colored pencil on the Pictorial as it is checked. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something you have consistently overlooked.

8. Check all component leads connected to the circuit boards. Make sure the leads do not extend through the circuit board and make contact with other connections or parts, such as coil shields or the chassis.

If the trouble is not located after the "Visual Tests" are completed and a voltmeter is available, check voltage readings against those shown in the Schematic Diagram and "X-Ray Views." A review of the "Circuit Description" may also help you determine the cause of a trouble.

Troubleshooting Chart

CONDITION	POSSIBLE CAUSE
No relative power output indication.	1. Driver trimmer capacitors not peaked. 2. Relay contacts not together. 3. Q6 and/or Q7 installed backwards. 4. Faulty diode D1.
Transmitter does not key.	1. Faulty Q12.
Crystal oscillator inoperative.	1. Driver trimmer capacitors not peaked with crystal when in crystal transmit mode.
Sidetone inoperative.	1. Faulty Q10 and/or Q11.
Relay inoperative.	1. Faulty Q8 and/or Q9.
Receiver section inoperative.	1. Faulty Q1.
No audio output.	1. Faulty IC1.

FACTORY REPAIR SERVICE

You can return your completed kit to the Heath Company Service Department to have it repaired for a minimum service fee. (Kits that have been modified will not be accepted for repair.) Or, if you wish, you can deliver your kit to a nearby Heathkit Electronic Center. These centers are listed in your Heathkit catalog.

To be eligible for replacement parts under the terms of the warranty, equipment returned for factory repair service, or delivered to a Heathkit Electronic Center, must be accompanied by the invoice or the sales slip, or a copy of either. If you send the original invoice or sales slip, it will be returned to you.

If it is not convenient to deliver your kit to a Heathkit Electronic Center, please ship it to the factory at Benton Harbor, Michigan and observe the following shipping instructions:

Prepare a letter in duplicate, containing the following information:

- Your name and return address.
- Date of purchase.
- A brief description of the difficulty.
- The invoice or sales slip, or a copy of either.
- Your authorization to ship the repaired unit back to you C.O.D. for the service and shipping charges, plus the cost of parts not covered by the warranty.

Attach the envelope containing one copy of this letter directly to the unit before packaging, so that we do not overlook this important information. Send the second copy of the letter by separate mail to Heath Company, Attention: Service Department, Benton Harbor, Michigan 49022.

Check the equipment to see that all parts and screws are in place. Then, wrap the equipment in heavy paper. Place the equipment in a strong carton, and put at least THREE INCHES of resilient packing material (shredded paper, excelsior, etc.) on all sides, between the equipment and the carton. Seal the carton with gummed paper tape, and tie it with a strong cord. Ship it by prepaid express, United Parcel Service, or insured parcel post to:

Heath Company
Service Department
Benton Harbor, Michigan 49022

SPECIFICATIONS

TRANSMITTER

DC Power Input	3 watts on 40 meters. 2.5 watts on 20 meters. 2 watts on 15 meters.
Frequency Control	40 meter crystal, or built-in VFO on 40 meters. 20 meter crystal or built-in VFO on 20 meters. 15 meter crystal, or built-in VFO on 15 meters.

CIRCUIT DESCRIPTION

The Low-Power CW Transceiver, Heathkit Model HW-7, covers the CW portions of the 40, 20, and 15 meter bands. The operating frequency is VFO (variable frequency oscillator) controlled on both transmit and receive, with provision for crystal transmit. Twelve transistors and one integrated circuit comprise the all solid-state circuitry. Requirements for an external power source are discussed in the Specifications section of the Manual.

VFO (VARIABLE FREQUENCY OSCILLATOR)

The heart of the Transceiver is the built-in VFO for both receive and transmit. Oscillator transistor Q2 operates at a frequency determined by coils L12 and L13, and the two section VFO capacitor, C51. In the 40 meter band position, the VFO is actually operating at an 80 meter frequency that is exactly half of the 40 meter dial frequency. Transistor Q3 is a buffer stage which provides isolation for the oscillator to eliminate frequency shifting.

Transistor Q4 acts as a doubler/tripler stage depending upon your band selection. In the 40 meter band, coil L3 and capacitor C29 are resonant at 40 meters which doubles the 80 meter oscillator frequency. Capacitor C57 couples the VFO frequency to the receiver section and capacitor C33 couples the frequency to the transmitter section.

In the 20 meter band, the oscillator (Q2) operates at a 40 meter frequency which is then doubled to 20 meters. In the 15 meter band, the oscillator also operates at a 40 meter frequency which is then tripled to 15 meters.

RECEIVER

The received signal is tuned by coil L1 and receiver preselector capacitor C1. Transistor Q1 is a detector which produces an audio signal from the mixing of the received signal and the VFO signal. The VFO signal is coupled to G2 of transistor Q1 by capacitor C57. Coil L14 and its associated capacitors form an audio selectivity filter with a cutoff frequency of about ~~2500~~ 1000 Hz. ~~As a result, the receiver can reproduce single-side-band and CW signals~~.

Audio is coupled to integrated circuit IC1 by capacitor C52 and resistors R41 and R6. IC1 is a linear IC made up of three individual high-gain audio amplifier stages. These amplifiers are cascaded to provide approximately 100 dB of gain which is controlled by AF Gain control R8. The audio output is coupled to Phones jack J2 by capacitor C17.

Sidetone Oscillator

Transistors Q10 and Q11 form the sidetone oscillator circuit which is keyed when the transmitter is keyed. (The keying circuit is discussed in the "Transmitter" section.) The generated sidetone is coupled to audio amplifier IC1 by capacitor C45. The sidetone is coupled to IC1 before the AF Gain control, so its audio level is also controlled.

TRANSMITTER

The transmitter circuitry consists of a crystal oscillator/driver stage, final amplifiers, and a pi-network output circuit for impedance matching and harmonic suppression. Transistor Q5 is the crystal oscillator and/or driver, depending on whether or not the transmitter is VFO or crystal controlled. If VFO control is used, the stage is only a driver which is resonance-tuned by the appropriate driver capacitor, C35 and C36, C37, and C38 with coil L2. When the crystal transmit button is pressed, the stage is a combination Pierce oscillator and driver. The transmitter output frequency is then the same as the external crystal, regardless of the VFO frequency. M417

Coil L2 couples the driver signal to the final stage that consists of transistors Q6 and Q7 operating in parallel. The RF output signal is switched through the appropriate pi-network which acts as a low-pass filter and provides the necessary impedance matching. Capacitor C42 is the Tuning control which should be adjusted for maximum power output on the relative power meter. Capacitor C43 acts as the loading capacitor across the output to the antenna. Capacitor C44 couples the RF output through relay RL1 to antenna jack J4. The meter circuit couples off a small portion of the RF output, which is then detected by diode D1. Meter M1 indicates the RF output as relative power.

Keying

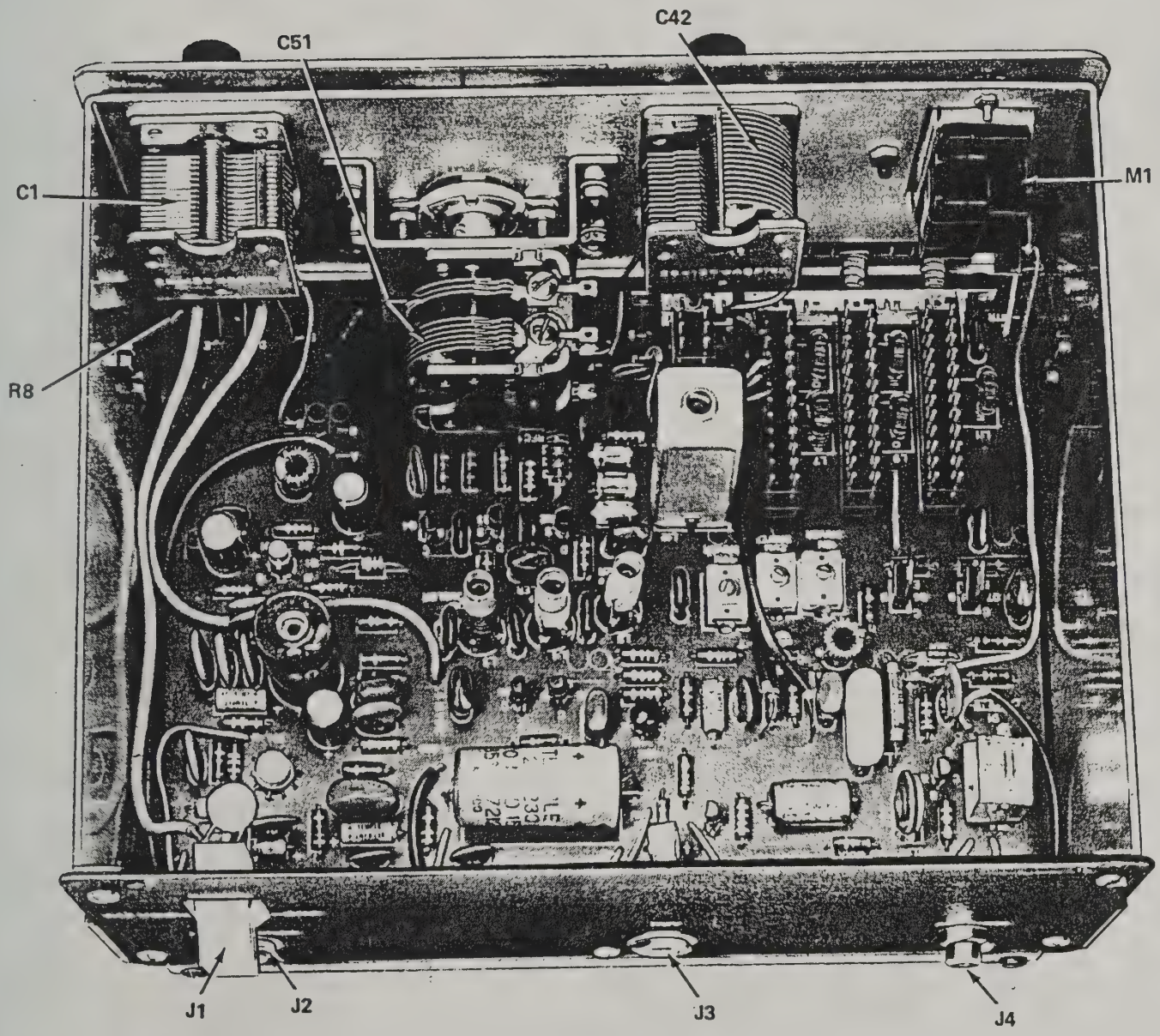
Transistor Q12 provides a keying function when the key is depressed. This transistor provides the keying for the transmitter driver stage, the sidetone oscillator, the break-in delay switching, and the receiver muting. When the key is depressed, the keying transistor places a B+ voltage on the collector of crystal oscillator/driver transistor Q5 and switches it on. The transmitter is then keyed and provides an RF output signal. The B+ voltage is simultaneously applied to the sidetone oscillator circuit which couples its tone to audio amplifier IC1.

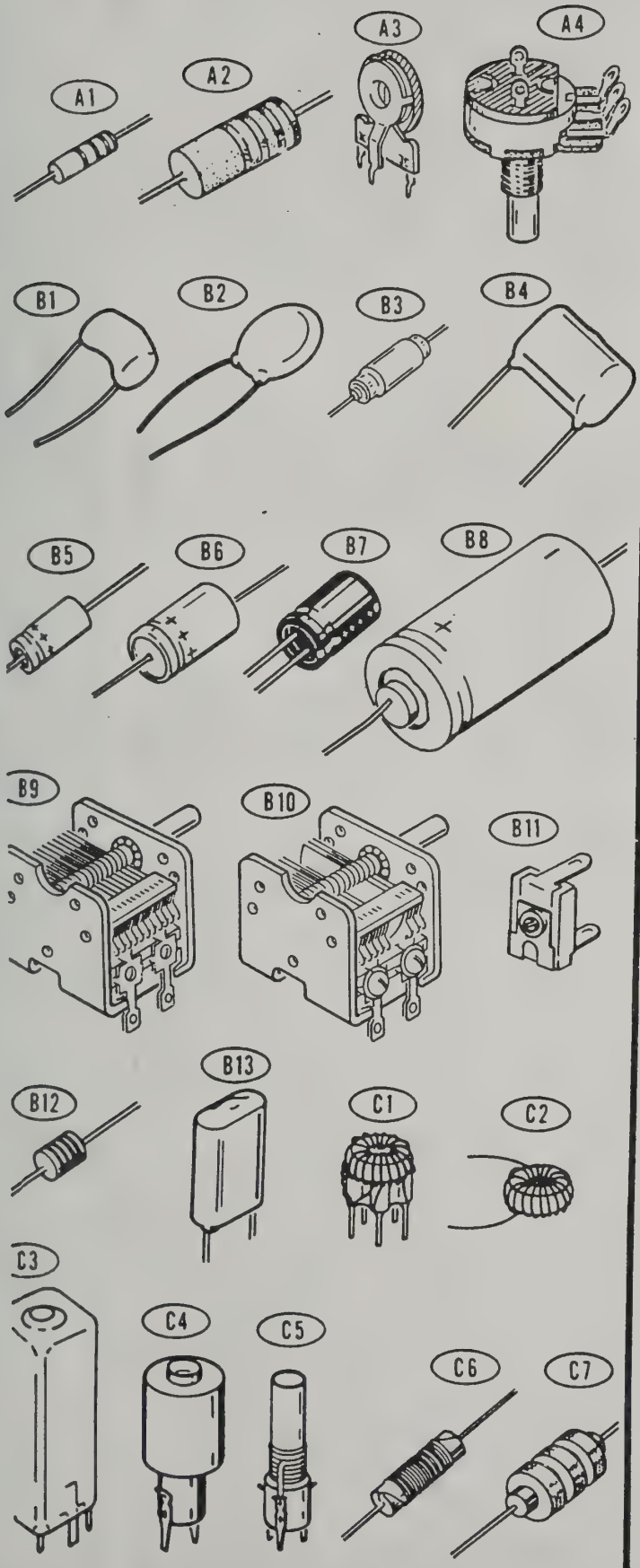
Depressing the key also places a ground on the emitter of break-in delay transistor Q8 and the input of audio amplifier IC1. The break-in delay circuit switches relay RL1 and connects the antenna to the transmitter. Since the ground is placed at the input to the audio amplifier, and the antenna is switched to the transmitter, no receiver signal is heard. The sidetone is coupled to the second cascaded amplifier of IC1 so the tone can then be heard in the headphones. When the key is released, keying transistor Q12 allows the Transceiver circuitry to return to the normal receive mode.

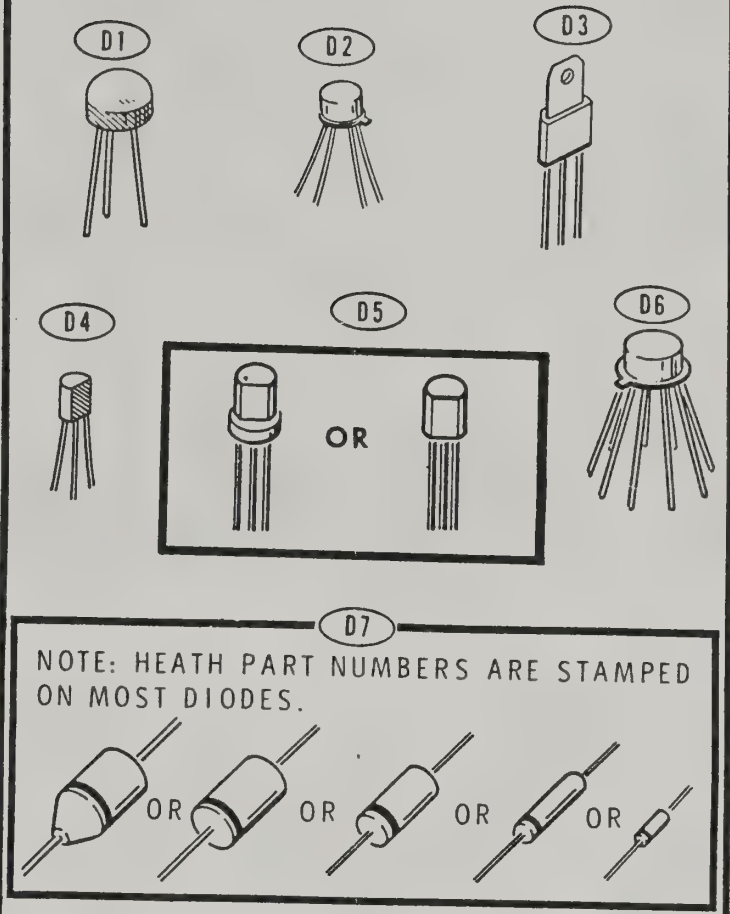
BREAK-IN DELAY

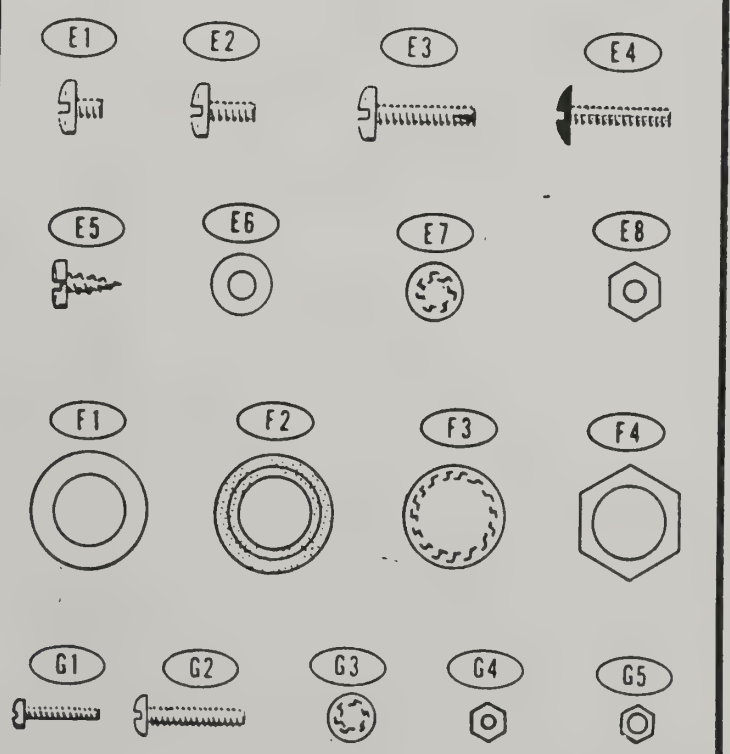
Transistors Q8 and Q9 provide an adjustable delay circuit for antenna switching. The emitter of break-in delay transistor Q8 is placed at ground when the key is depressed. This pulls the collector to ground which causes relay driver transistor Q9 to energize relay RL1 and switch the antenna from receive to transmit. Relay RL1 will remain energized until the base voltage of relay driver transistor increases to the B+ voltage. When the key is released, the emitter and collector voltages of Q8 try to increase toward B+. Capacitor C19 simultaneously tries to discharge through delay control R8 which determines the break-in delay time. The collector voltage of Q8 will gradually increase until it reaches B+ which causes the base voltage of relay driver transistor Q9 to increase toward B+. This causes relay RL1 to de-energize and switch the antenna from transmit to receive.

CHASSIS PHOTOGRAPHS

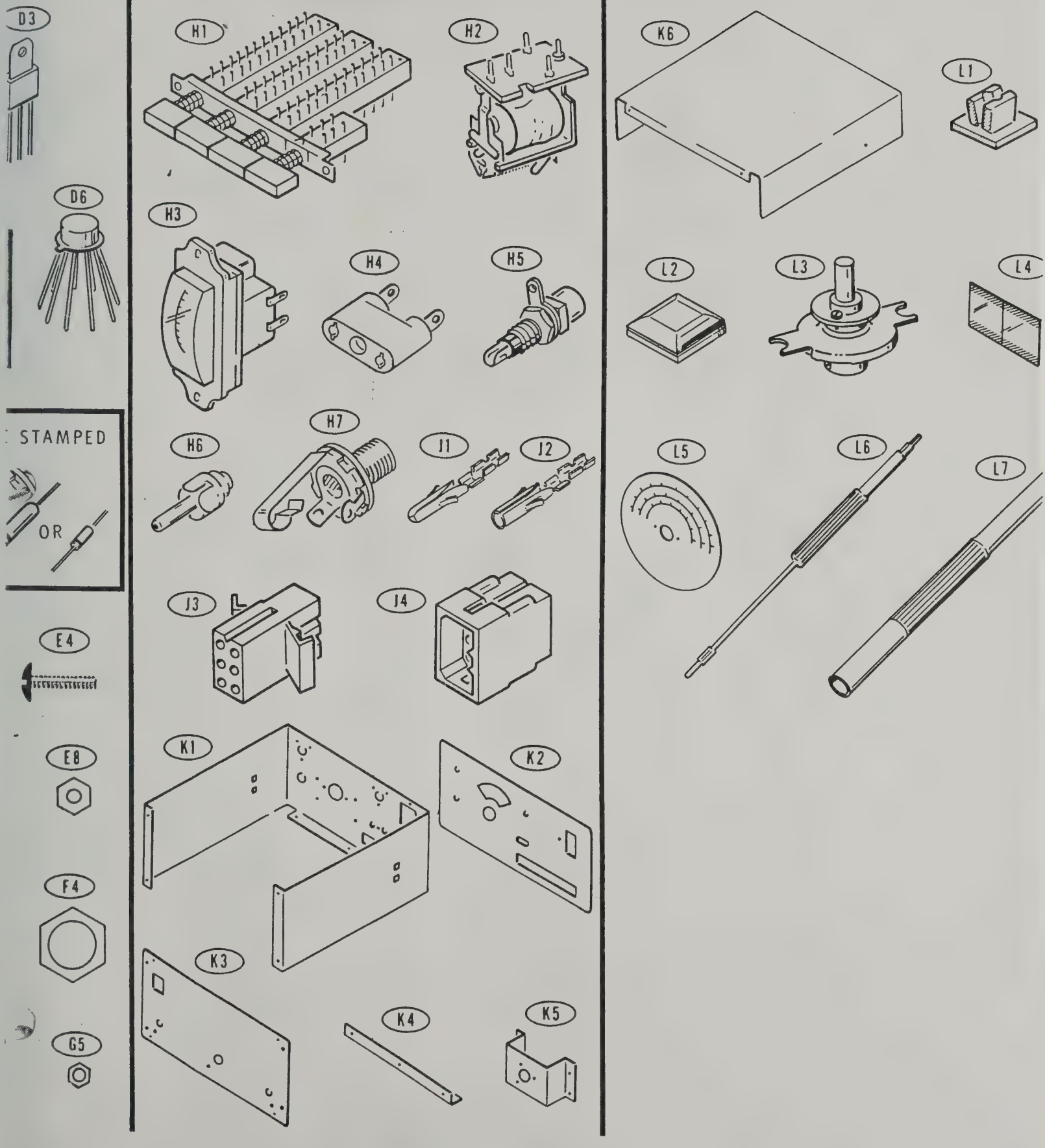


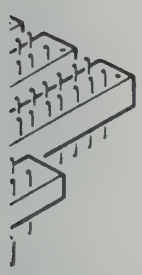

A1
A2
A3
A4
B1
B2
B3
B4
B5
B6
B7
B8
B9
B10
B11
B12
B13
C1
C2
C3
C4
C5
C6
C7


D1
D2
D3
D4
D5
OR
D6
D7
NOTE: HEATH PART NUMBERS ARE STAMPED ON MOST DIODES.
OR
OR
OR
OR

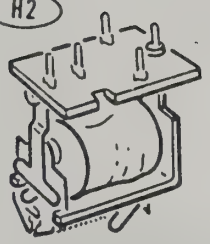

E1
E2
E3
E4
E5
E6
E7
E8
F1
F2
F3
F4
G1
G2
G3
G4
G5

ARTS PICTORIAL

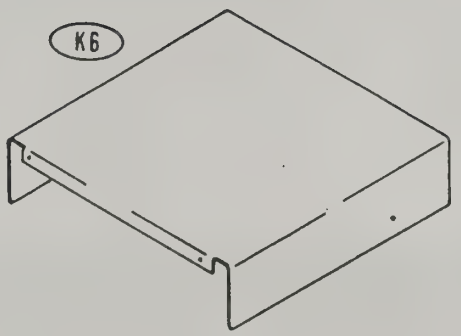




H2

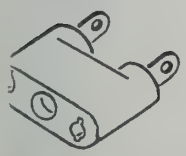


K6



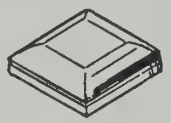
L1

H4



H5

L2



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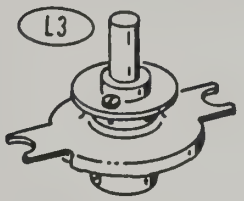

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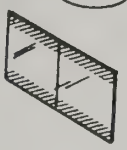

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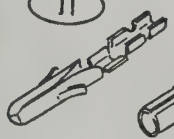
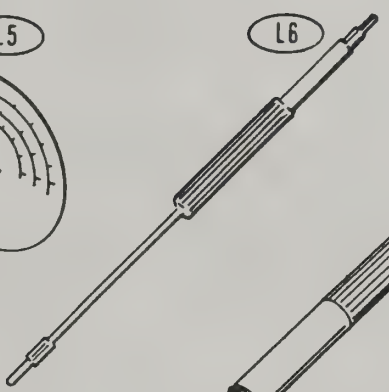


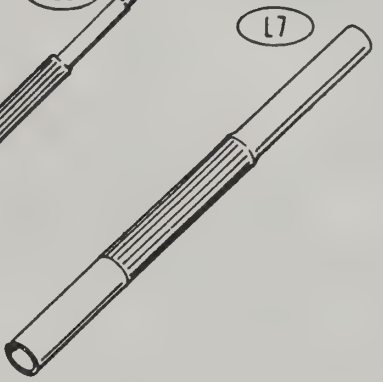
I2

L5

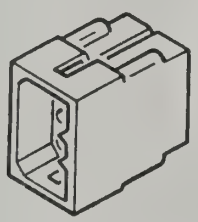
L6



L7



I4



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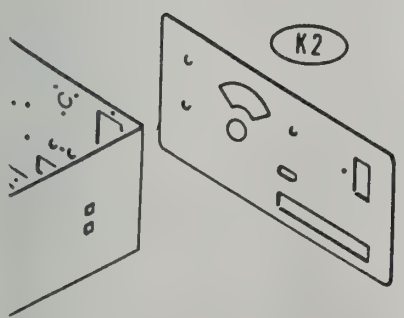

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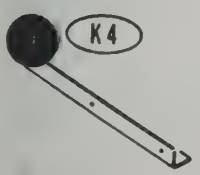

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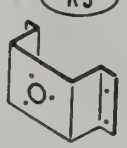
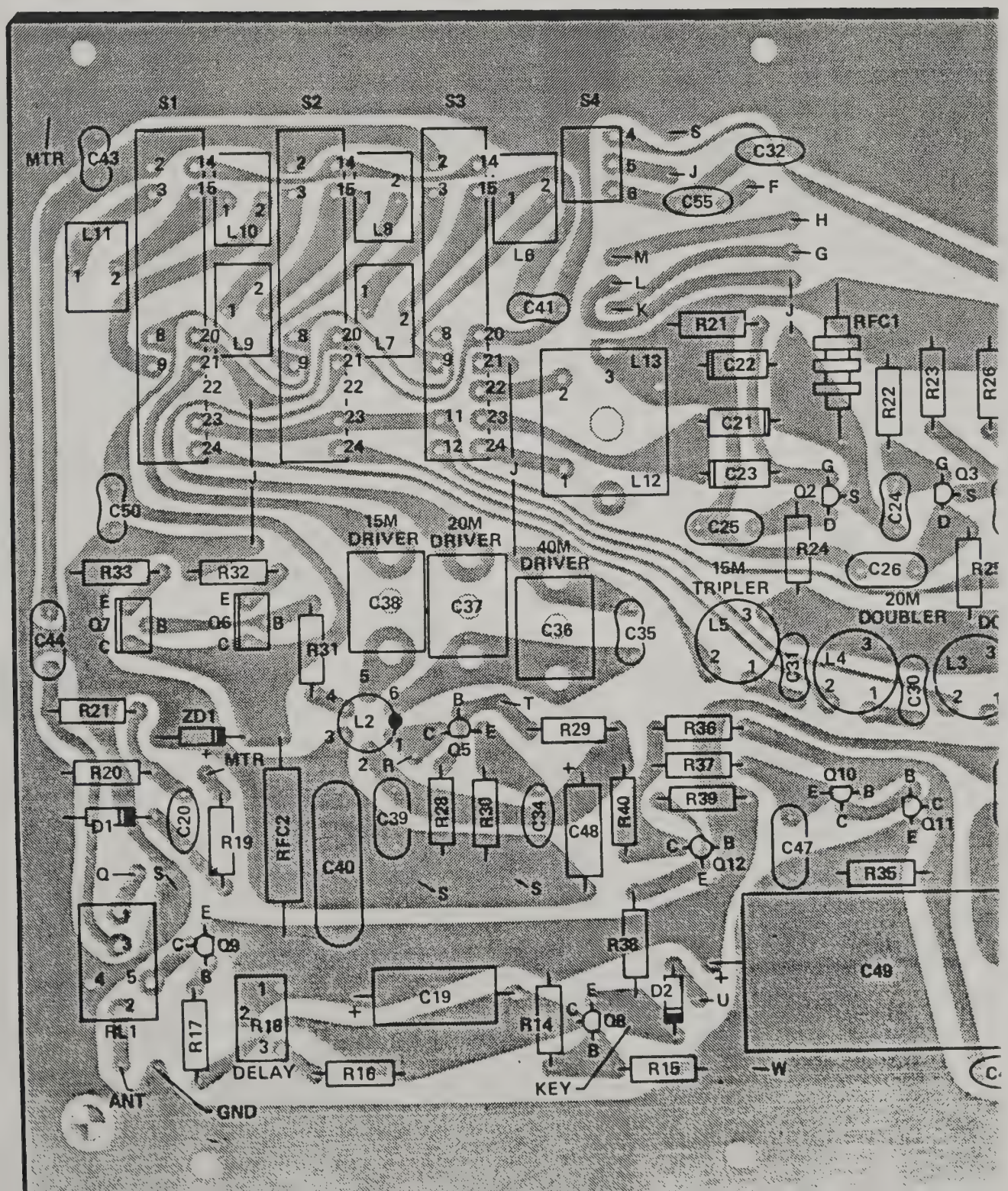


NOTE: To identify a part shown in one of these Views, so you can order a replacement, proceed as follows:

1. Note the identification number of the part (R-number, C-number, etc.).
2. Locate the same identi the part) on the Sche of the part (for exan 2N2712) will also appe
3. Look up this Descriptic

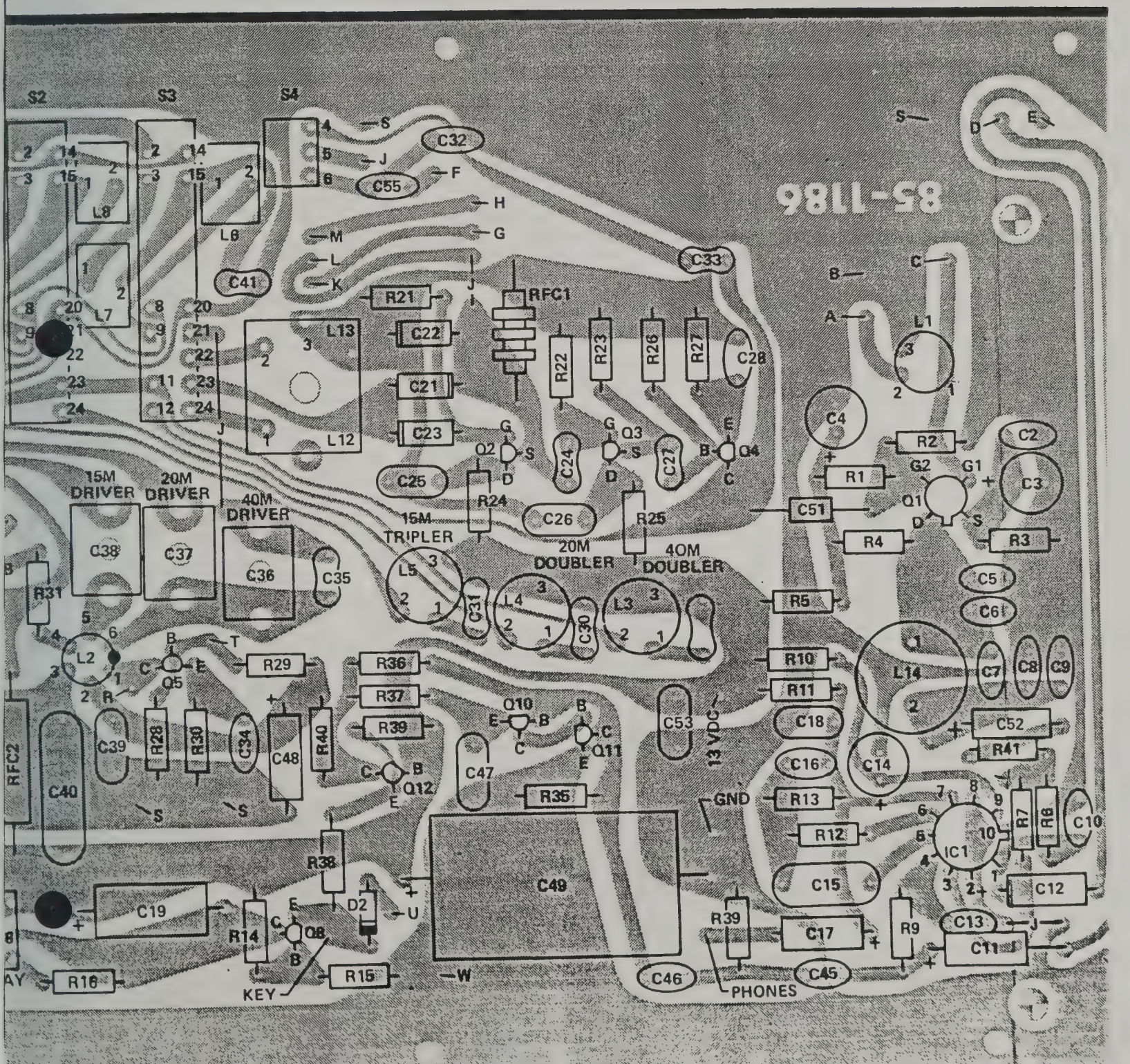


hown in one of these Views, so
, proceed as follows:

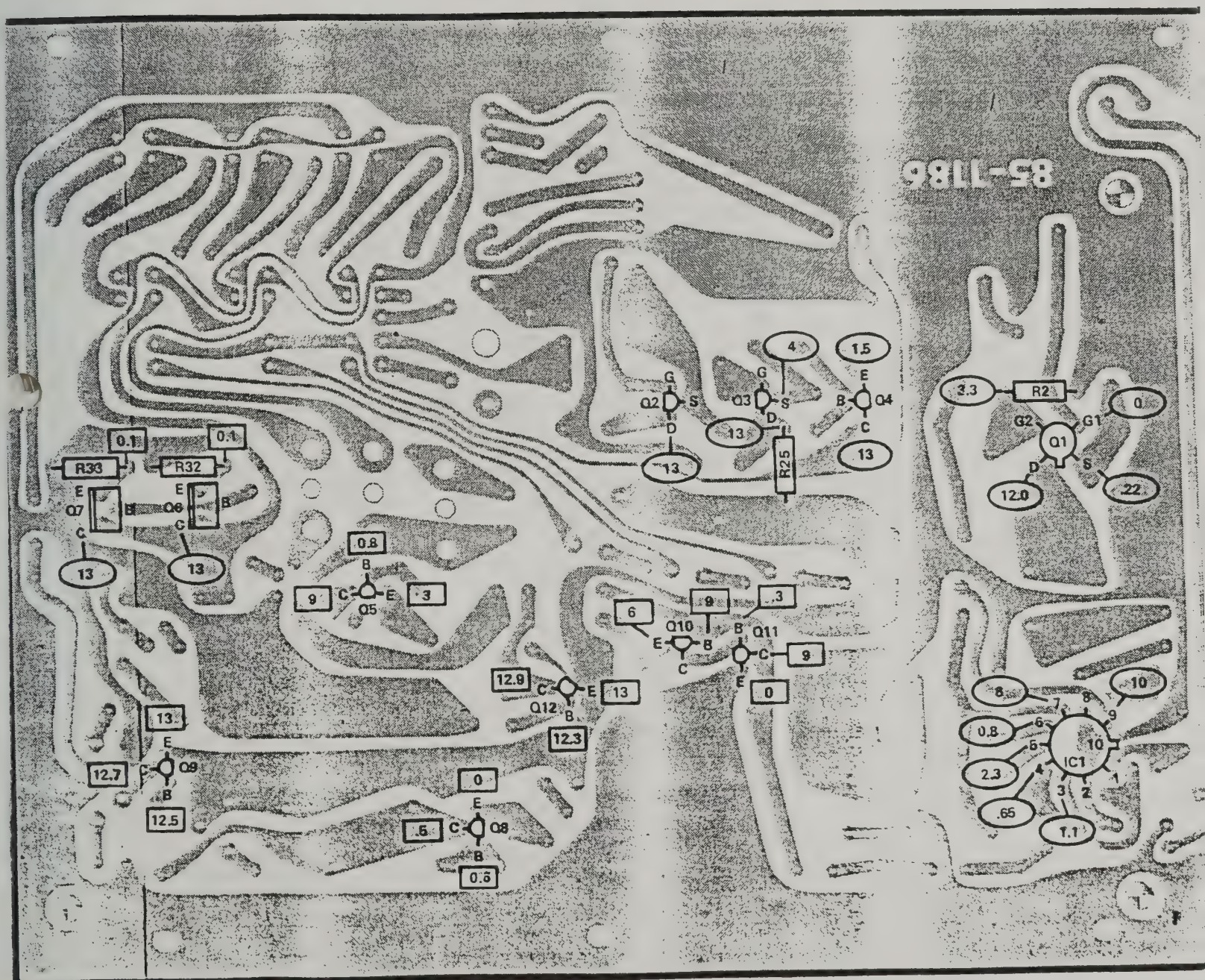
ification number of the part
mber, etc.).

2. Locate the same identification number (next to the part) on the Schematic. The "Description" of the part (for example: 22 kΩ, .05 μF, or 2N2712) will also appear near the part.

3. Look up this Description in the Parts List.



CIRCUIT BOARD VOLTAGE CHARTS

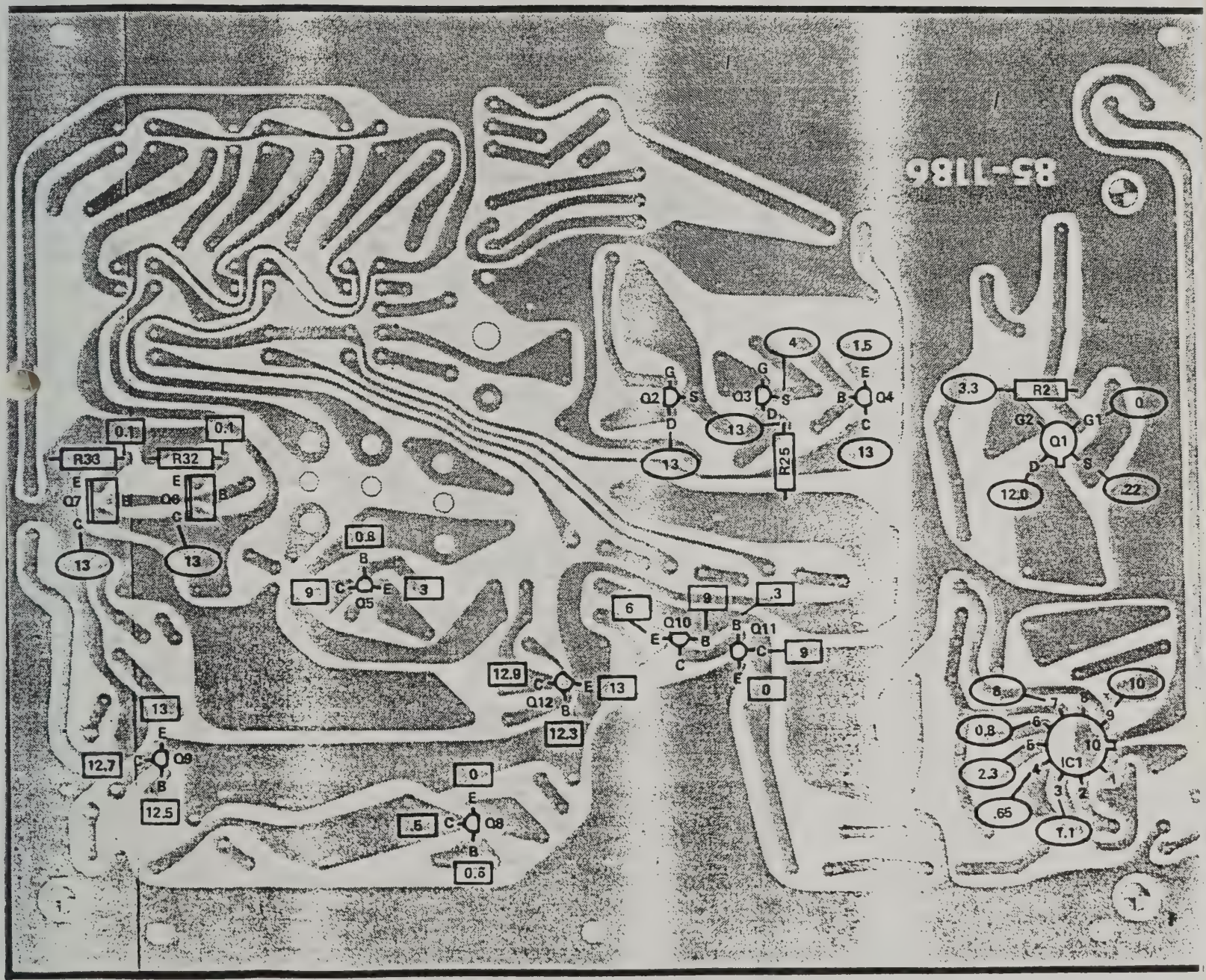


Transmit

Receive

(Viewed from foil side)

CIRCUIT BOARD VOLTAGE CHARTS

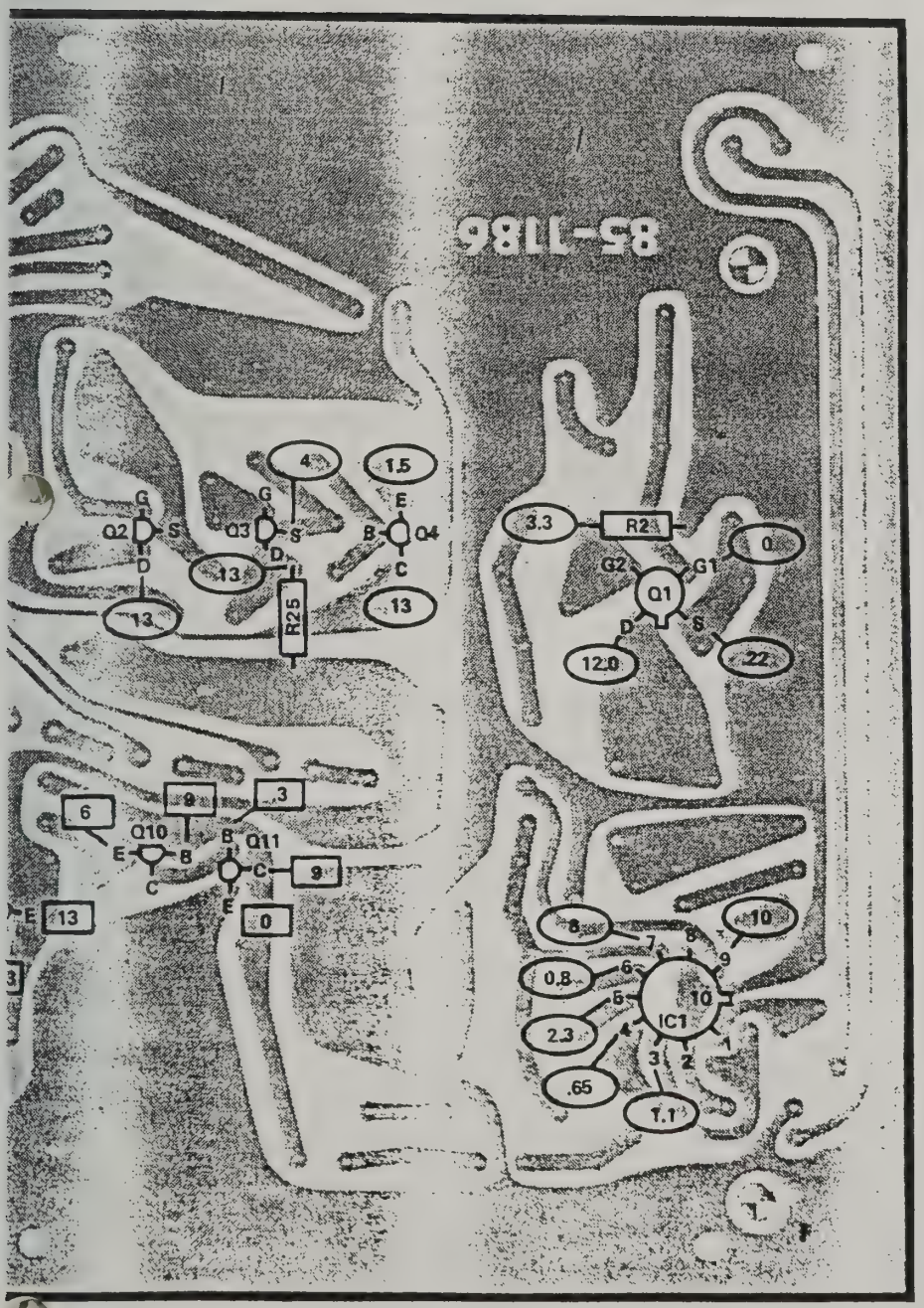


Transmit

Receive

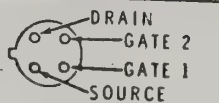
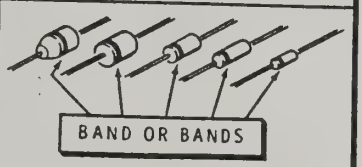
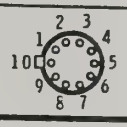
(Viewed from foil side)

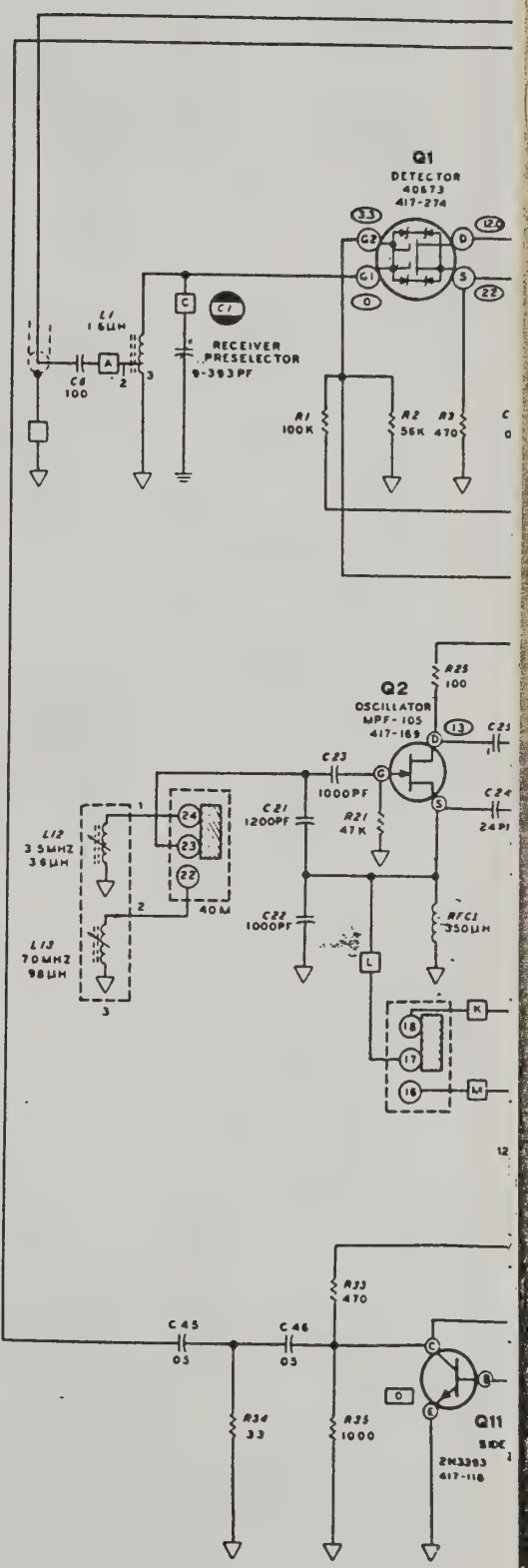
BOARD VOLTAGE CHARTS

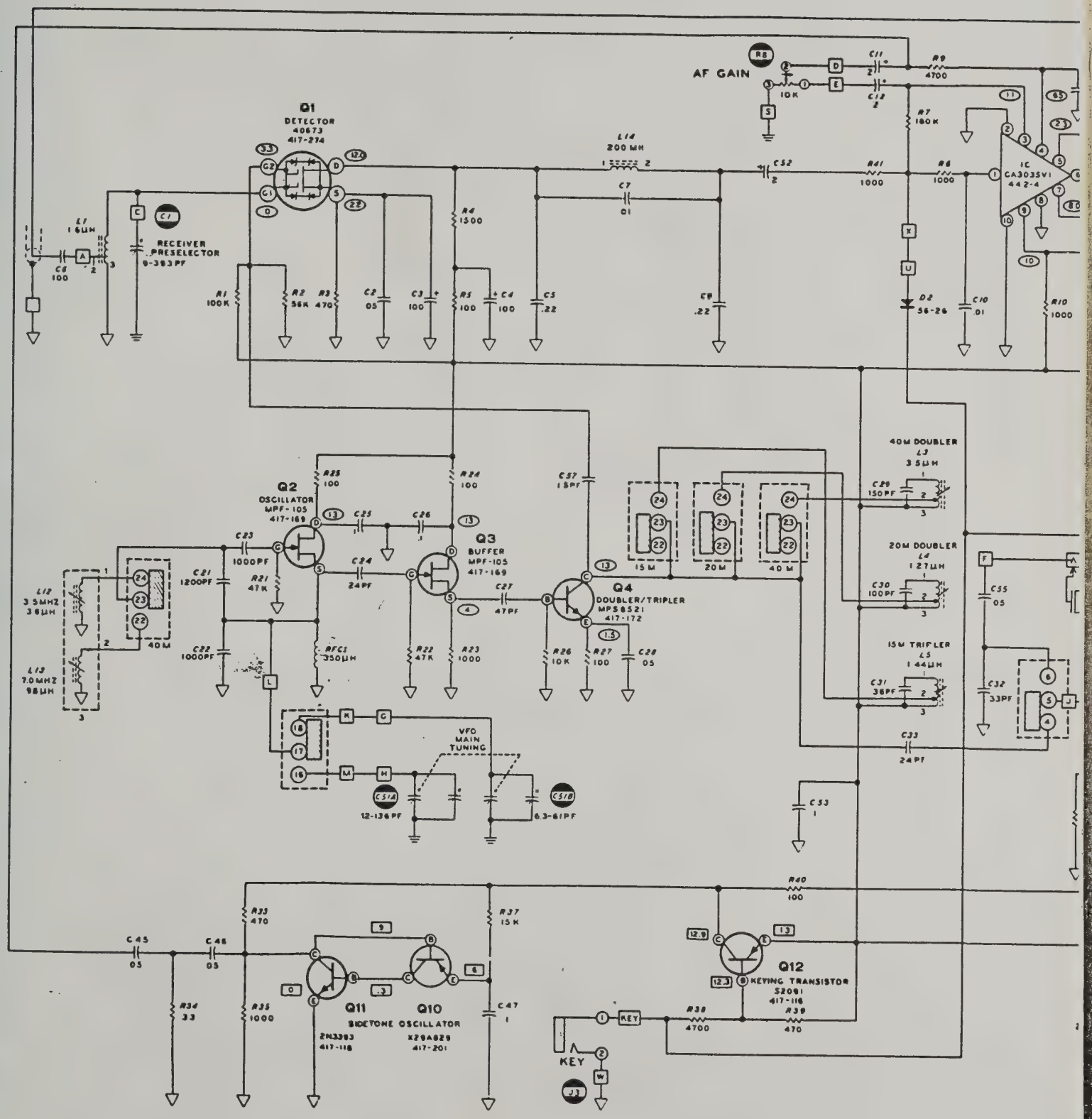


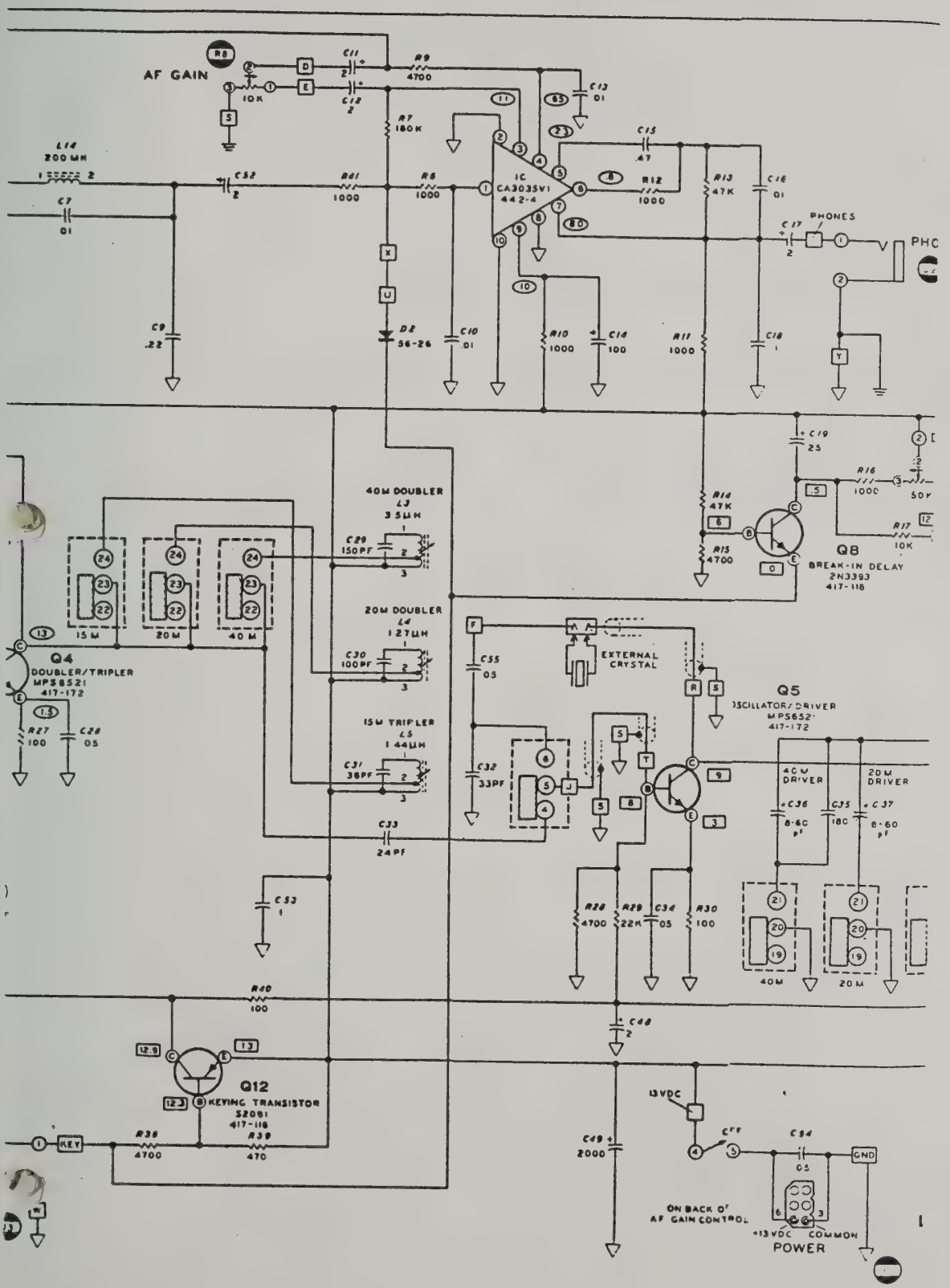
ed from foil side)

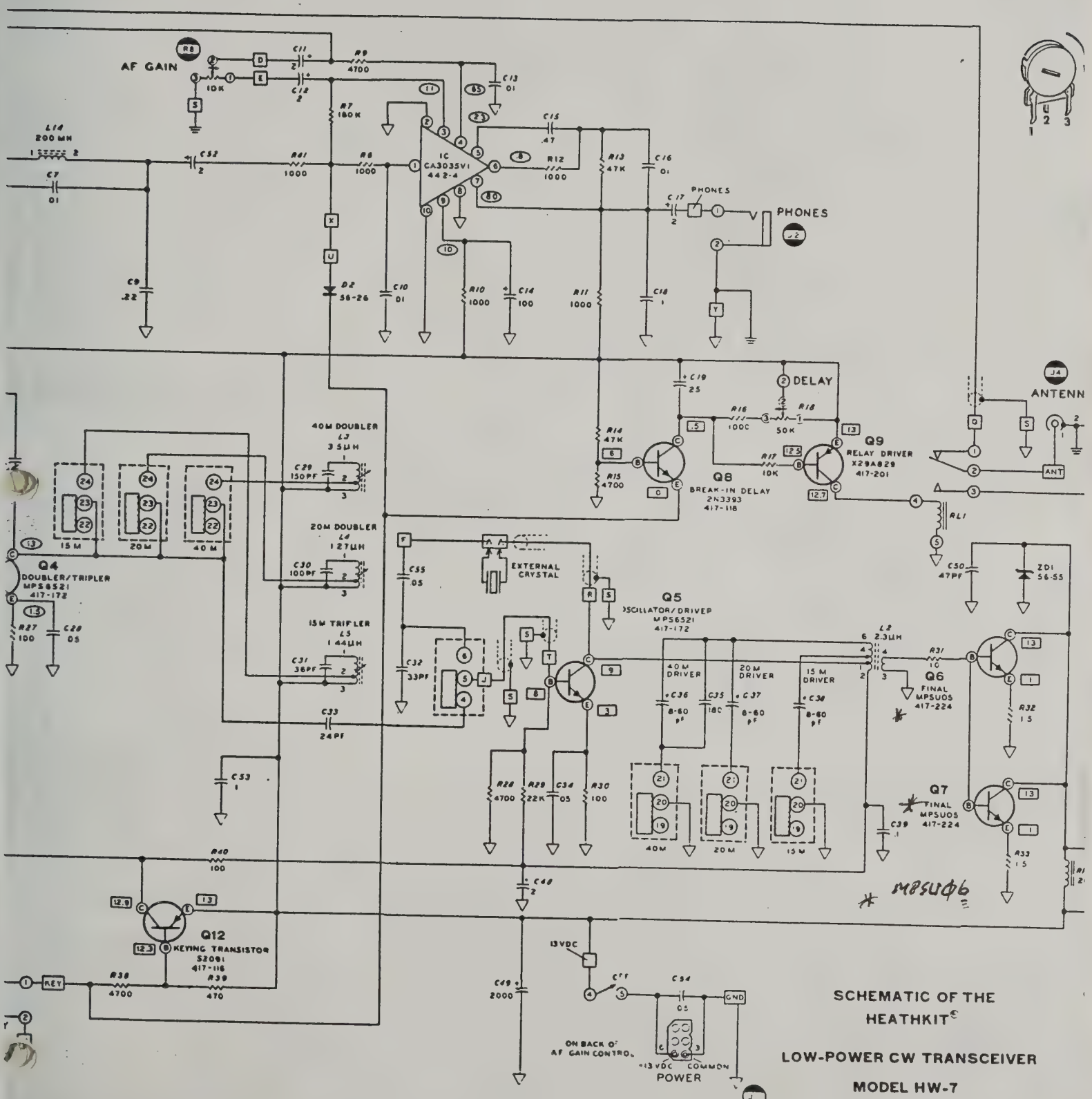
BASING DIAGRAMS

COMPONENT	HEATH PART NUMBER	MAY BE REPLACED WITH	BASE DIAGRAM (BOTTOM VIEW)
Q1	417-274	RCA 40673	
Q8, Q11	417-118	G.E. OR T.I. 2N3393	
Q9, Q10	417-201	G.E. OR T.I. X29A829	
Q12	417-116	FAIRCHILD S2091	
Q2, Q3	417-169	MOT. MPF105	
Q4, Q5	417-172	MOT. MPS6521	
Q6, Q7	417-224	MOT. MPSU05	
D1, D2	56-26	1N191	
ZD1	56-55	VR-36A	
IC1	442-4	CA3035V1	




AF GAIN
R8
10K
C11
2
C12
2
R9
4700
R7
180K
Q1
DETECTOR
40673
417-274
L14
200 MH
C52
2
R41
1000
R6
1000
IC
CA3035V1
442-4
C7
01
R4
1500
L1
1.6µH
C1
RECEIVER
PRESELECTOR
9-393PF
C8
100
R1
100K
R2
56K
R3
470
C2
05
C3
100
R5
100
C4
100
C5
.22
CR
.22
D2
56-26
C10
.01
R10
1000
Q2
OSCILLATOR
MPF-105
417-169
R25
100
R24
100
C25
C26
C23
1000PF
C24
24PF
Q3
BUFFER
MPF-105
417-169
C21
1200PF
R21
47K
C27
47PF
Q4
DOUBLER/TRIPLER
MPS6521
417-172
C57
18PF
40M DOUBLER
L3
3.5µH
C29
150PF
20M DOUBLER
L4
1.27µH
C30
100PF
15M TRIPLER
L5
1.44µH
C31
36PF
15M
20M
40M
L12
3.5MHZ
3.6µH
40M
L13
7.0MHZ
9.8µH
C22
1000PF
RFC1
350µH
R22
47K
R23
1000
R26
10K
R27
100
C28
05
C55
05
C32
33PF
C33
24PF
C53
1
VFO
MAIN
TUNING
C51A
12-136PF
C51B
6.3-61PF
R40
100
R33
470
R37
15K
C45
05
C46
05
Q11
Q10
SIDETONE OSCILLATOR
2N3393
417-118
X29A029
417-201
Q12
KEYING TRANSISTOR
S2091
417-116
R34
33
R35
1000
C47
1
R38
4700
R39
470
KEY
J3

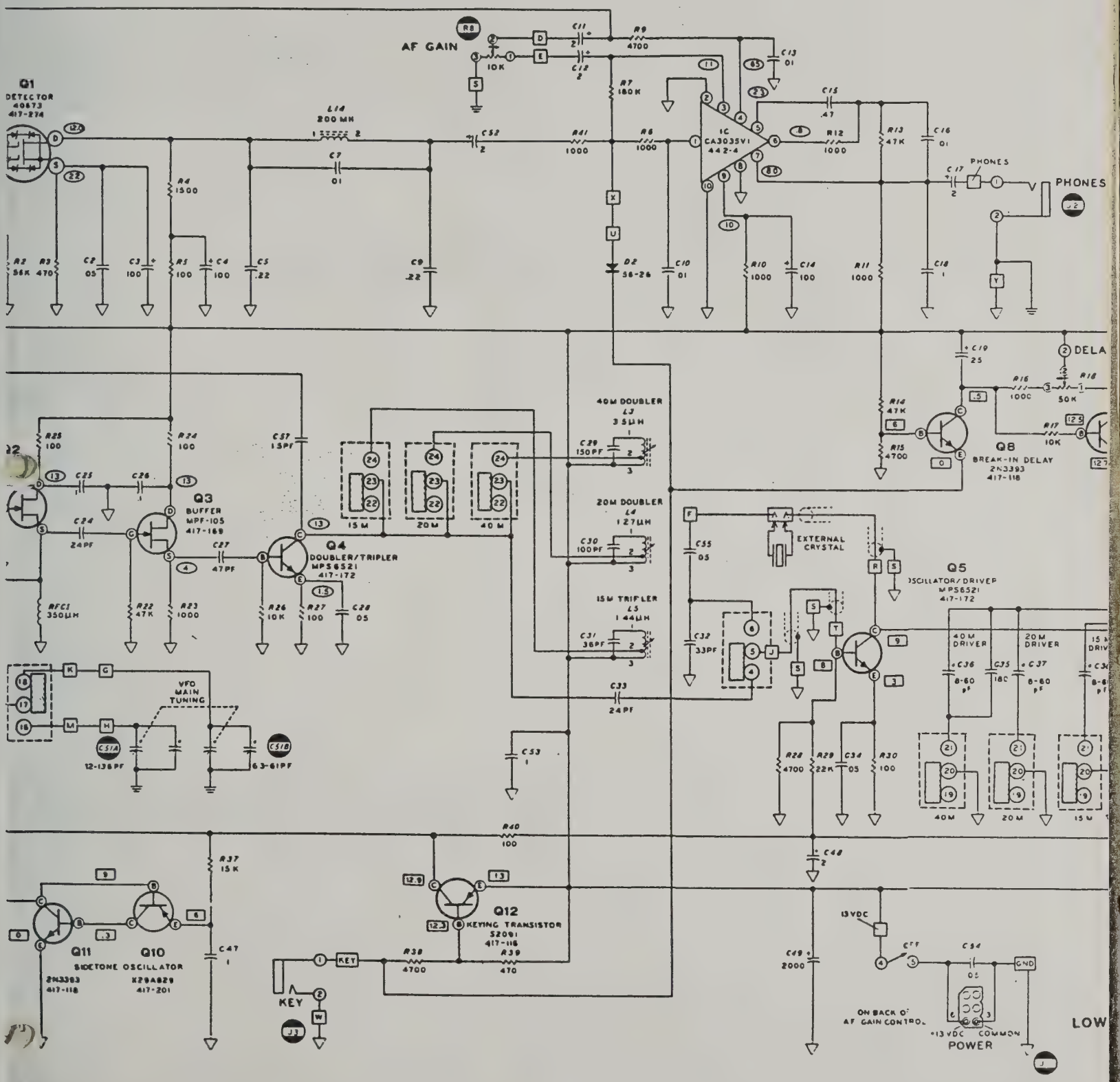

AF GAIN
R8
10K
C11
C12
R9
4700
C13
.01
R7
180K
L14
200 MH
C7
.01
C32
R41
1000
R6
1000
IC
CA3035V1
442-4
C15
.47
R12
1000
R13
47K
C16
.01
PHONES
C17
PHC
C9
.22
D2
56-26
C10
.01
R10
1000
C14
100
R11
1000
C18
1
C19
25
R16
1000
50K
R14
47K
R15
4700
R17
10K
Q8
BREAK-IN DELAY
2N3393
417-118
40M DOUBLER
L3
3.5 UH
C29
150PF
20M DOUBLER
L4
1.27 UH
C30
100PF
15M TRIPLER
L5
1.44 UH
C31
38PF
15 M
20 M
40 M
Q4
DOUBLER/TRIPLER
MPS6521
417-172
R27
100
C28
.05
C33
24PF
C53
1
EXTERNAL
CRYSTAL
C55
.05
C32
33PF
Q5
OSCILLATOR/DRIVER
MPS6521
417-172
40 M
DRIVER
20 M
DRIVER
C36
8-60
pF
C35
180
C37
8-60
pF
R28
4700
R29
22K
C34
.05
R30
100
40M
20M
R40
100
C48
2
Q12
KEYING TRANSISTOR
S2081
417-116
KEY
R38
4700
R39
470
C49
2000
13 VDC
C55
.05
GND
ON BACK OF
AF GAIN CONTROL
+13 VDC
COMMON
POWER



SCHEMATIC OF THE
HEATHKIT©

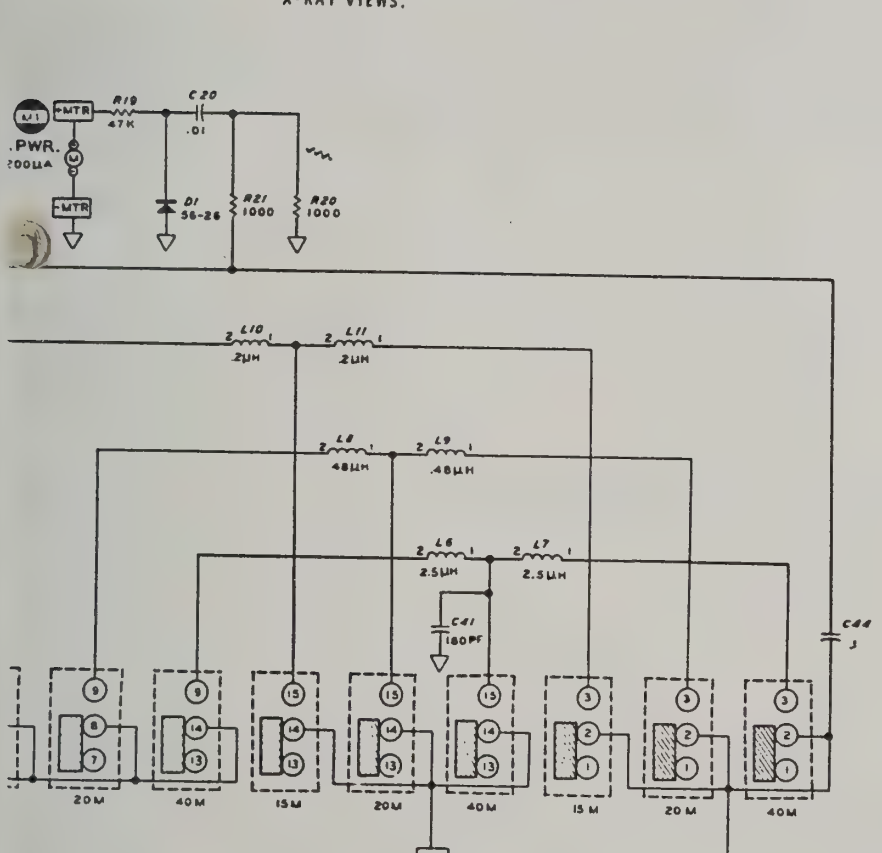
LOW-POWER CW TRANSCEIVER

MODEL HW-7


AF GAIN
10K
Q1
DETECTOR
40673
417-274
L14
200 MH
IC
CA3035V1
442-4
PHONES
PHONES
J2
D2
56-26
Q8
BREAK-IN DELAY
2N3393
417-118
Q3
BUFFER
MPF-105
417-169
Q4
DOUBLER/TRIPLER
MPS6521
417-172
40M DOUBLER
L3
35 µH
20M DOUBLER
L4
1.27µH
15M TRIPLER
L5
1.44µH
15M
20M
40M
RFC1
350µH
VFO
MAIN
TUNING
12-136PF
63-61PF
EXTERNAL
CRYSTAL
Q5
OSCILLATOR/DRIVER
MPS6521
417-172
40M
DRIVER
20M
DRIVER
Q11
Q10
SIDETONE OSCILLATOR
2N3393
417-118
X29A829
417-201
Q12
KEYING TRANSISTOR
S2091
417-116
KEY
J3
13VDC
ON BACK OF
AF GAIN CONTROL
+13 VDC
COMMON
POWER
J1
LOW

NOTES:

1. ▭ INDICATES A LETTERED CIRCUIT BOARD HOLE.
2. ▽ INDICATES A CIRCUIT BOARD GROUND.
3. ⏚ INDICATES A CHASSIS GROUND.
4. ⬭ INDICATES A VOLTAGE MEASURED IN THE RECEIVE MODE.
5. ▭ INDICATES A VOLTAGE MEASURED IN THE TRANSMIT MODE.
6. ⬬ INDICATES A CHASSIS MOUNTED PART EVEN THOUGH ITS POSITION ON THE SCHEMATIC INDICATES OTHERWISE.
7. ALL VOLTAGES WERE MEASURED WITH AN 11-MEGOHM-INPUT VTVM FROM THE POINT INDICATED TO CHASSIS GROUND. VOLTAGES MAY VARY ±10%.
8. ALL RESISTORS ARE 1/2 WATT.
9. ALL CAPACITOR VALUES ARE IN µF UNLESS OTHERWISE SPECIFIED.
10. ⟵ INDICATES CLOCKWISE ROTATION OF A CONTROL AS VIEWED FROM THE KNOB END OR AS SHOWN FOR CIRCUIT BOARD CONTROLS. THE CIRCUIT BOARD CONTROL LUG NUMBERS CORRESPOND TO THOSE SHOWN ON THE SCHEMATIC AND X-RAY VIEWS.



Heathkit Service Bulletins for the HW-7

February 16, 1973
HW-7 QRP Transceiver
Bulletin No: HW-7-1

Dail Rubbing

To Prevent the dial rubbing against the front panel the following change has been made in production. Replace the [4] 253-27 flat washers with two aluminum spacers, Part No: 255-1.

****

February 16, 1973
HW-7 QRP Transceiver
Bulletin No: HW-7-2

Broadcast Interference

In spite of the article in the January issue of QST, page 48, we do not plan to make a modification kit for this problem. However, we plan to track the identity of all purchaser's and mail the information and parts to them individually. To service those we miss [retail sales primarily], the attached information sheet will suffice. The parts should be furnished at no charge. Only those with serial numbers starting '002' require the change. Others already have them in the kit itself.

****

February 16, 1973
HW-7 QRP Transceiver
Bulletin No: HW-7-3

Low Audio Level - Receiver

Replace R411 [10K Ohm] Part # 1-20 with 1000 Ohm, Part #1-9. This is a production change which should be made in all kits with SN's starting with '002'.

****

February 16, 1973
HW-7 QRP Transceiver
Bulletin No: HW-7-4

Service Hints

RECEIVER: The receiver section of the HW-7 is basically a direct conversion type circuit. The incoming signal is mixed with the on-frequency VFO signal to provide audio output.

The audio is filtered by the lowpass audio filter and coupled to the audio IC which has approximately 100db of gain. A certain amount of microphony is normal for this type of circuitry.

Normal sensitivity for this receiver is less than 1uv will provide a

readable signal. This is normal since all Protos and Field Test Units showed much better sensitivity.

Typical RF voltage readings at the detector FET Q1 are .6 to 1 volt RMS nominal measured on Boonton 91-C meter. Any injection appreciably less than .4 volt RMS will give a loss of sensitivity. NOTE: This voltge is not a pure sine wave.

When Receiveing a signal, the front panel preselector control must be carefully peaked in the designated areas.

VFO/DOUBLER/TRIPLER

The Colpitts oscillator operates on 3.5 to 3.6 MHZ and doubled to 7.0 to 7.2 MHZ for 40 Meter operation. For 20 and 15 Meter operation, the oscillator runs at 7.0 to 7.1 MHZ and doubled for 20 meter [14.0 to 14.2 MHZ] and tripled for 15 meters [21.0 to 21.3 MHZ]. Following are typical RF readings:

Gate of Q3 = Approx. 1 Volt RMS [Sine wave]
Base of Q4 = Approx. .8 Volt RMS [Approx. Sine wave]
Collector of Q4 = Sine wave with harmonics

OSC./DRIVER and RF AMPLIFIER

Base of Q5 [xmit] = 1 to 2.5 Volts RMS [not Sine wave]
Base of Q6, Q7 = 1.5 to 2.5 Volts RMS [not Sine wave]
RF output across 50 Ohm load should be approximately 10 Volts RMS [Sine wave for all bands].

Possible problem area in transmitter may be two extremely mis-matched out transistors [high gain with low gain]. This may cause one transistor to "hog" all the current thereby destroying itself. When this happens, also check zener diode ZD1 for possible open circuit. If instability is a problem, also check ZD1 for open circuit.

****

May 3, 1974
HW-7 QRP Transceiver
Bulletin No: HW-7-5

Audio ["popcorn"] Noise Reduction

The following modification will reduce the noise level of the CA-3035V1 audio IC considerably:

1] Connect a 220K [PN 1-29] resistor and a .1uf [PN 21-95] disc IN SERIES from pin 4 to pin 5 of the CA-3035V1 on the foil side of the board.

2] Connect a 1 uf Electrolytic [PN 25-197] from pin 6 of the CA-3035V1 to the ground foil between pins 2 and 8.

****

July 12, 1974
HW-7 QRP Transceiver
Bulletin No: HW-7-6

Sensitivity Improvement

1] Jumper a small wire across C6 [100pf] on the foil side of the board.

2] Remove R1 [100K Resistor].

NOTE: If the unit fails to operate, or there is no increase in sensitivity with this resistor removed, it should be resinstalled in the circuit.

These circuit changes are to be made only as needed.

****

March 26, 1975
HW-7 QRP Transceiver
Bulletin No: HW-7-7

Pulse Oscillation on 40 Meters

If the HW-7 has an oscillator problem, check to see if Q2 is a Teledyne device rather than a Motorola.

To prevent the circuit from pulse oscillating, install a ferrite bead [PN 475-10] on the gate lead if Q2 is a Teledyne type.

HW-7 Modifications

A. Remove and discard capacitors C-5, C-6, C-8, C-9.
B. Replace C-5 and C-9 with .22uf mylar capacitors.

A. Lift coax from point A on circuit board.
B. Install 100pf mica capacitor between center conductor of coax and point A. [Improves BCB rejection].

A. Install heat sinks on transistors using silicone grease for PA protection.

PARTS LIST

[2]	.22UF	27-85
[1]	100PF	20-102
[2]	#4-40X1/2" SCREW	250-52
[2]	#4 LOCKWASHER	254-9
[2]	#4-40 NUT	252-15
[1]	SILICONE GREASE	352-13
[2]	HEAT SINK PLATE	205-1436

****

April 17, 1975
HW-7 QRP Transceiver
Bulletin No: HW-7-8

Modifications F/U/W the HD-1410 Keyer

The HW-7 keying circuit was designed to be compatible with the HD-10 keyer. This is the reason that the key jack has the tip contact grounded. Two changes should be made to the HW-7 to allow use with the HD-1410:

A] The two wires going to the HW-7 key jack should be reversed.

B] R39 should be changed from 470 Ohm to 4700 Ohm.

Use Your Browsers *BACK* Key to Return to the Previous Page

Better Ears for the HW-7

BY

Michael A. Czuhajewski WA8MCQ
7945 Citadel Drive
Severn, MD 21144

This is 1995, but the venerable Heathkit HW-7 transceiver is still out there, and I see ads for them from time to time. This was the first of three QRP transceivers that Heath sold, designed back in the days when direct conversion receivers had a well deserved bad reputation (much worse than they do now). In comparing the various Heath HW-rigs in 73 magazine several years ago, Mike Bryce, WB8VGE, said the receiver in the HW-7 "sucked canal water." Those who have operated HW-7s know that he was being kind.

DC RECEIVER PROBLEMS

Many people don't like DC receivers today because you can hear signals on both sides of zero beat, but trust me, that's nothing compared to some of the other problems they used to have. Early DC receivers suffered from a number of worse maladies; these included massive hum when using AC power supplies and tuning the preselector just right ("tunable hum"), as well as AM detection of shortwave broadcast stations. The hum could be worked around by using batteries, by using a bifilar wound choke in the power lead from an AC supply, or bypassing the diodes in that AC supply with disc capacitors.

However, there was not much that could be done about the shortwave stations; that was caused by AM detection in the receiver, and no matter where you tuned in the band it was always there, across the entire dial. It was a constant background companion, Father like having a radio going on the other side of the room. The cure to these problems was pointed out by W7EL in his August 1980 QST article, "An Optimized QRP Transceiver", and also by K70WJ in his July/October 1986 QRP Quarterly article, "A High Performance Direct Conversion Receiver". (That's not a two part article; this was the year the QRP Quarterly skipped a beat for some reason and missed an issue.)

The problems didn't exist in just the HW-7, either -- the early TenTec PM- series used essentially the same design in the receiver and had the same problems, as did many homebrew rigs of the day.

The common factor was that all of these used dual gate MOSFETs as a mixer. Those provide conversion gain, but have an unfortunate side effect-they also make good square law detectors, and provide envelope detection of AM signals. Wait a minute-some older commercial receivers and transceivers used dual gate MOSFETs as first mixers and yet they don't have shortwave BC stations blanketing the dial-how do they get away with it? The key is that those units are all superhets; the MOSFET mixers are detecting the AM signals all right, but the output of the mixer goes to an IF amplifier, and an IF amp tuned to 455 KHz or somewhere in the MHz region certainly isn't going to pass an audio frequency signal. In the case of the direct conversion receiver, the mixer output goes directly to so audio amplifier chain, without passing through any tuned circuits which block out audio frequencies, so the detected AM gets passed on, along with the desired signals.

THE CURE

The key is to get rid of the dual gate MOSFET mixer and replace it with a double balanced diode ring

mixer. These have been around for years, both home brew and commercial (such as the Mini Circuits Labs SRA-1, SBL-1, TUF-1, etc). Just like Roy and Denton said, these cut out the tunable hum and shortwave BC stations. (The technical details are beyond the scope of this article, but have been well documented in the ham press.)

A CURE IN 1987

The October 1987 issue of the QRP Quarterly had an article by John Collins, KN1H, titled "Making the HW-7 Into a Radio". Unfortunately, both the text and schematic are rather confusing and hard to follow, and John was never very happy with the translation his manuscript and drawing suffered between his hand and the pages of the Quarterly. I've sent photocopies of the article to many people over the years, along with a warning that they could get confused easily. I've been promising myself to update it for several years, and here it is at last!

THE ORIGINAL RECEIVER

Figure 1 is the basic receiver chain of the HW-7. Parts designators are those used by Heath. The signal comes from the T/R relay through C6, to the preselector (C1 and L1). It is fed into one gate of Q1, and the other gate gets the VFO signal from 04, the doubler/tripler which follows the VFO buffer. (R1 and R2 set the bias for that gate.) Q1 mixes them and the output passes through an audio filter (L14, C5, C7 and C9) and then into a CA3035 integrated circuit audio amp.

Here are the parts values used in the original receiver.

C1 393 pF	R1 100K
C2 .05	R2 56K
C3 100	R3 470
C4 100	R4 1500
C5 .22 (.01)	R5 100
C6 100 (.01)	R6 1K
C7 .01	R7 180K
C8 none (.01)	R41 1K
C9 .22 (.01)	L1 1.6 uH
C10 .01	L14 200 mH
C52 2 uf	
C57 15 pf	

(Note-I have two different HW-7 schematics; in the older one, the capacitor on the left leg of L14 is a pair of .01 caps in parallel, C5 and C6, and the connection from the antenna goes directly to the tap on L1, with no capacitor. The cap on the right leg of L14 is another pair of .01's, C8 and C9.)

THE KN1H FIX

The KN1H modification consists of rewiring Q1 into an amplifier for the VFO signal so it can drive a DBM (the MCL SRA-1 in his case, although the SBL-l is just as good, and cheaper) as the local oscillator (LO), and feeding the signal from the preselector into the RF port of the mixer. The audio output (IF port) is then fed into a preamplifier he added, and on to the CA3035. Q1 itself was left in place on the circuit board; some of the surrounding components were changed in value, some new ones added, some traces cut, etc, to turn it into an amplifier.

All of that made things a bit hard to follow, but it did work. It would be much easier if all of the circuitry was built up on a single board from scratch, rather than modifying the HW-7 board. While I haven't actually done that part myself, the diagrams here should make the process much easier and clearer.

PART OF THE ORIGINAL KN1H ARTICLE

"My HW-7 was found at a hamfest several years ago. It was terribly dirty but carried a $15 price tag. So, with a warning from its owner that it didn't receive "too well", I carried it home and plugged it in. Well, the original owner was at least partly right&emdash;it didn't receive at all, or transmit either!

"I pulled out the PNP transistor that was in the oscillator section and replaced it with the FET which belonged there, and in a few days had a working HW-7. The transmitter worked pretty well and on receive I could listen to the VOA, the BBC and our local AM station all at once on 40 meters. I could also listen to 20 meter CW stations on 15 meters. That is, if they were stronger than the ever-present common-mode hum. "This HW-7 was looking less like a bargain all the time, but by now, with $15 and several days invested, I was determined to make a radio out of this thing.

GET A NEW MIXER

"First, the 40673 product detector had to go. The square law characteristics of the dual gate MOSFET make it a wonderful detector of any AM signal that appears at its input. The passive double balanced mixer I put in its place has no such tendencies (due to its balance); it does suffer from conversion loss, the requirement for a high level of local oscillator (LO) injection, and a low impedance output.

"The LO requirement was met by simply reconfiguring the 40673 as a broadband amplifier to boost the LO level going into the DBM. T1 is a broadband transformer with 35 turns on the primary and 5 turns on the secondary, wound on an FT37-43 toroid. This delivers about +5 dBm into the 50 ohm impedance of the DBM-a little less than the optimum +7 dBm, but it works quite well. "The conversion loss and low output impedance problems are both handled by a neat trick first published by PA0SE, Dick Rollema, "Second Thoughts on the Direct Conversion Receiver", Ham Radio, November 1977, pages 44-55. (This article is highly recommended to anyone interested in DC receivers.) The audio output of the DBM is fed directly into a miniature audio transformer with a high turns ratio, which feeds a FET amplifier. The transformer performs several functions all at once. First, it provides a low impedance for the DBM to see, and then it steps the audio voltage up to a high level which improves the FET noise characteristics. The transformer I used is an 8 ohm to 15K ohm unit found in the junk box. It has a 44:1 turns ratio (the square of the turns ratio = impedance ratio), and works well; but an even higher ratio might work better.

A FREE FILTER

"Capacitor CT across the secondary was chosen to resonate the winding at 750 Hz. This cleans up the waveform and gives a 3 dB bandwidth of about 1 KHz. A free audio filter! The value of C will have to be determined experimentally as the secondary inductance of your transformer will undoubtedly be different from mine. My C turned out to be 0.015 uF. [And beware of using a disc ceramic capacitor here&emdash;I did, and it turned out to be an excellent source of microphonics! Many ceramic capacitors exhibit the piezoelectric effect and can generate small voltages when tapped&emdash;and this capacitor is followed by a high gain audio amp. -WA8MCQ]

"Almost any FET will yield good results in this circuit, but some will be better than others of the same type number. One particular 5308 I had gave about 10 dB more gain than its nearest competitor, so it was used here.

"These modifications completely cured the AM breakthrough and common-mode hum problems [see

sidebar], even when using an AC power supply. The problem with 20 meter stations breaking through on 15M was helped (but not totally eliminated) by feeding RF to the DBM from the tap on the preselector coil (L1) rather than the top of L1 [as done in the original HW-7 circuit]. With this arrangement, preselector tuning is much sharper and there is probably a closer match to the input impedance of the DBM. Also, C6, originally 100 pF, was changed to 0.001 uF which resulted in a 6 dB signal increase on 40M, but no change on 20 and 15.

"The added portions of this modification were assembled, ugly fashion, on a piece of double-sided PCB which was then bolted to the side wall of the HW-7 chassis. RF and LO interconnections were made with RG-174 mini coax, and +12V is supplied from the ON-OFF switch.

[Description of reworking the original 40673 circuit by changing and removing parts and cutting traces is deleted. While it can be done, it's a bit confusing and hard to follow, and it's probably better to simply build up the circuitry on a separate board. -- WA8MCQ]

"I have found this modification to be extremely worthwhile; the HW-7 is now a thoroughly usable QRP rig with a pleasant sounding receiver. Not bad for a $15 radio) With the hamfest season approaching, let me suggest you keep an eye out for an HW-7. When you have made the modifications described, it may become your favorite rig.

WATCH OUT FOR TRANSFORMER HUM

When I modified my HW-7 according to Johns instructions, I used whatever audio transformer was handy and small enough to fit. The turns ratio wasn't as large as he used, but it was adequate. (I believe it was 8 to 2000 ohms.) There is one problem with using the transformer&emdash;if you put the modified rig too close to a power supply, hum may be induced in the audio of the HW-7, coupling magnetically between it and the supplys transformer. The solution is simple&emdash; reorient the power supply, or move it farther away from the rig. ("Doctor, it hurts when I do this." "Well then, don't DO that!")

ROOM FOR EXPERIMENTATION

This isn't necessarily the best audio preamplifier circuit, but it does work. You might want to experiment with something else, such as the circuit used in the W7EL Optimized QRP Transceiver (August 1980 QST and the second printing--not first-of QRP Classics from ARRL). You might also want to experiment with a different audio amp, such as an LM-386, LM-380, etc, and perhaps insert a filter. This is not the only way to fix an HW-7 receiver section, but gives you the basic idea. There is lots of room in the HW-7 for modifications.

If you see an HW-7 at a "good" price, don't pass it up because of bad things you may have heard about its receiver. It CAN be fixed!

COMMON MODE HUM

What is common-mode hum? That was one of the many shortcomings of early DC receivers, also known as tunable hum. When operating on an AC power supply, you could tune the preselector to peak signals, and at the same time hum would start coming through. It is now generally accepted that the cause of this is VFO energy leaking out and getting back to the diodes in the power supply, being modulated with 60 Hz AC, reradiated and picked up by the receiver along with desired signals. Some cures were mentioned above--do away with the AC power supply completely, or put a choke between it and the receiver to

keep the VFO energy from getting to the diodes, or bypass each diode in the rectifier with a capacitor so the signal couldn't be modulated.

-- WA8MCQ

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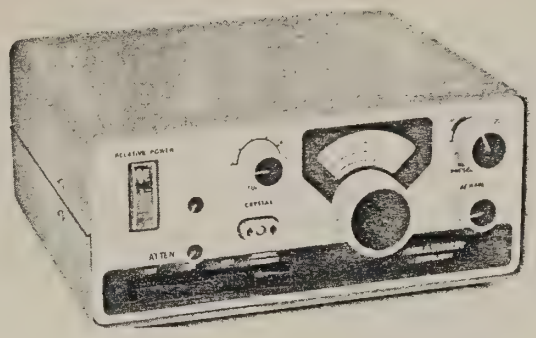


Exterior view of the modified HW-7. The two small controls at the left are the rf-gain and keyer-speed adjustments. A switch (upper right) is used in place of the front-end-peaking variable capacitor. Large Kurz-Kasch aluminum knobs have been added to provide greater purchase when adjusting the controls.

HW-7 QRP Transceiver Modifications

BY DOUG DE MAW,* W1CER

QRP OPERATION is again coming into focus for experimenting amateurs. The QRP-interest pendulum has gone through its arc a number of times over the years, and peak activity by low-power enthusiasts resulted from some stimulus which fired their imaginations. In bygone days, the motivation to try flea power came generally from construction articles in ham radio journals and handbooks. More recently, the manufacturers have provided part of the incentive to pursue awards such as WAS and DXCC while using only a few watts of rf power. Certainly, the availability of Heath and Ten Tec QRP transceivers has done much toward encouraging QRP operation. But, there are a great many technically oriented amateurs who welcome the challenge of designing and building their own low-power gear, having been "turned on" by the availability and reasonable cost of modern solid-state devices. To those of us who subscribe to the doctrine of low-power operation, there is considerable satisfaction in being able to effect world-wide communication with ten watts or less of output power. The result of marketing and selling several thousand QRP transceivers illustrated in a rather paradoxical manner that not everyone wants or needs a 1-kW station.

This article offers information that should be of technical interest to the builders of homemade gear. To those who do not design equipment, but own and operate HW-7 transceivers, a kit-form approach is given for assembling a new receiver front-end section. The circuit described here will cure the case-history ailments common to the equipment under discussion. The problems of overloading, cross modulation, low sensitivity, and poor selectivity can be resolved by substituting the circuit of Fig. 1 for the somewhat basic 40673 detector in the original design. Elimination of the oft-encountered ac hum is another benefit which will result from the modification suggested here. Some additional circuit changes are included to provide improved performance in other parts of the overall circuit.

* *QST* Technical Editor.

Comparing the Circuits

A single tuned circuit is used to establish the existing front-end selectivity in the unmodified receiver. The designers used a high-capacitance/low-inductance tuned circuit at the input to the 40673 detector. A single-section 393-pF variable (panel mounted) tunes the 1.6-μH inductor to resonance on 40, 20 and 15 meters, thereby requiring that the operator exercise care in selecting the correct peak response when changing bands. It is possible to find more than one peak, owing to the harmonic currents in the VFO output, and some responses will occur on out-of-band commercial signals.

The circuit of Fig. 1 eliminates the basic problem because of increased front-end selectivity, which is established by use of two fixed-tuned resonant circuits. Toroidal inductors are employed at L2 and L3, and the Q_u (unloaded Q) is fairly high, being approximately 180 on each band. Band selection is accomplished by switching in a separate pair of trimmers for each range of interest. The overall bandwidth of the fixed-tuned front end is

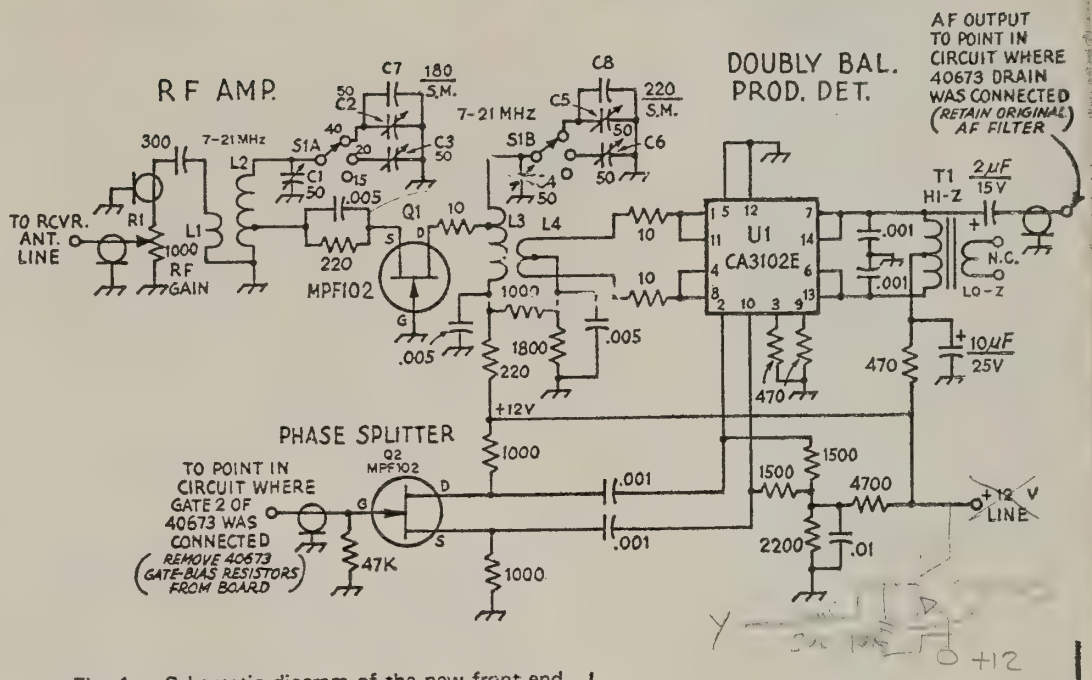


Fig. 1 — Schematic diagram of the new front end for the HW-7 receiver. Fixed-value capacitors are disk ceramic unless indicated otherwise. Polarized capacitors are electrolytic. Fixed-value resistors are 1/2-W composition.

C1-C6, incl. — Miniature 50-pF ceramic trimmer (Erie 557-006-8-50 or equiv.).

L1 — 2 turns No. 24 enam. over L2 winding.

L2 — 21 turns No. 24 enam. on Amidon T-50-6 toroid core (2 μH). Tap 7 turns up from ground.

L3 — Same as L2 except tap at 5 turns from C4/S1B end.

L4 — 6 turns No. 24 enam., center tapped.

Q1, Q2 — Motorola MPF102 or HEP802.

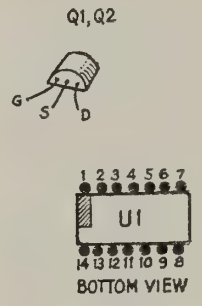
R1 — 1000-ohm linear-taper miniature carbon control (Mallory 13L or equivalent).

S1 — Two-pole, 3-position rotary wafer switch, miniature type, phenolic or ceramic.

T1 — Subminiature transistor output transformer, 1000- or 500-ohm ct primary to 8-ohm sec. Sec. not used.

U1 — RCA integrated circuit. Check Yellow Pages in phone book for address of nearest RCA distributor.

EXCEPT AS INDICATED, DECIMAL VALUES OF CAPACITANCE ARE IN MICROFARADS (μF); OTHERS ARE IN PICOFARADS (pF OR μμF); RESISTANCES ARE IN OHMS; k = 1000, M = 1000 000.



ample for the cw portions of 40, 20, and 15 meters, thereby eliminating the need for a peaking control on the front panel.

A grounded-gate JFET, Q1, is used as an rf amplifier. This provides approximately 10 dB of gain while establishing a low noise figure. Performance on 20 and 15 meters is greatly enhanced as a result. A simple rf-gain control is shown at the input to L1. It can be used to reduce overloading effects from the guy down the street who runs a high-power station. It need not be included if you do not live in close proximity to other stations.

A doubly balanced product detector, U1, replaces the 40673 circuit. An RCA CA3102E was selected for the job because of its high f_T and low noise figure. It contains two differential bipolar pairs, and two current sources. The differential pairs are cross-connected to provide the doubly balanced configuration (Fig. 2). It is necessary to supply the rf and local-oscillator energies in push pull. L4 serves in that manner, and Q2 is used as a phase splitter to convert the existing single-ended local oscillator output to the push-pull format. Output from U1 is taken in push-pull by means of T1, which is center tapped. Af voltage is sampled at one end of the transformer only, to assure compatibility with the single-ended audio amplifier which follows.

Obtaining CW Selectivity

Single-signal reception is not possible with the original direct-conversion receiver in the unit under discussion, nor is it with the new circuit. This means that QRM can exist from stations that might otherwise not be heard in a more sophisticated receiver. Therefore, it is advantageous to provide as much selectivity as practical to lessen the effects of QRM. In the HW-7, a passive m-derived low-pass audio filter is employed. The constants used provide suitable passband characteristics for ssb reception, but miss the target completely for cw operation, the mode for which the equipment was designed. Thus, a marked improvement can be realized by adding an *RC* active audio filter, peaked at, say, 750 Hz. Fig. 3 shows the two-pole filter used by the writer. U2 is a dual op-amp IC which is available from most Radio Shack stores. The circuit is patterned after the MFJ Enterprises CWF-3 filter, available in kit form or wired.[1] Those wishing to purchase the kit may do so, for it will provide identical performance to the circuit of Fig. 3. As the diagram illustrates, the filter is inserted between the first and second sections of the cascaded audio amplifier contained in the RCA CA3035V1. Most op amps are inherently noisy, generating approximately 5 mV of peak-to-peak random hash. If the filter were connected directly at the detector output, the noise would be amplified by the 120-dB-gain CA3035V1 and would always appear in the headphones, thereby hampering weak-signal reception. When installed as shown in Fig. 3, the first section of the CA3035V1 establishes the noise figure (low) of the audio channel, and no hash is discernable in the headset.

Construction

The new receiver front end is contained on one pc board. Double-clad board is used to provide a ground plane on the component side of the module. Capacitance exists between the etched foils and the ground-plane side of the board. The capacitance is beneficial in reducing the possibility of hf and vhf parasitic oscillations and also discourages problems brought about by ground loops on a pc board. After the board is etched, holes are drilled for mounting the parts, then the copper around each hole (ground-plane side of board) is cut away by applying the point of a sharp 1/4-inch drill bit. The bit can be spun by hand, and a few revolutions will remove the unwanted copper which would otherwise cause short circuits as the pigtails came in contact with it. It is possible that single-clad pc board could be used without bad effects. It was not tried with this circuit.

The completed board should be mounted near the band-change switch which is used in place of the front-end tuning capacitor. All rf signal leads should be kept short, but audio leads can be long if shielded wire is used for them. The new assembly should be mounted in the HW-7 as shown in the photograph.

There is little to do concerning tuneup of the completed circuit. One trimmer for each tuned circuit is always in parallel with its respective coil. Those trimmers are peaked for maximum signal response on 21 MHz. They are not to be adjusted again. The remaining bands are selected one at a time and the related trimmers are adjusted for peak signal level. Adjust each set of trimmers for the center of the cw band in which they are used.

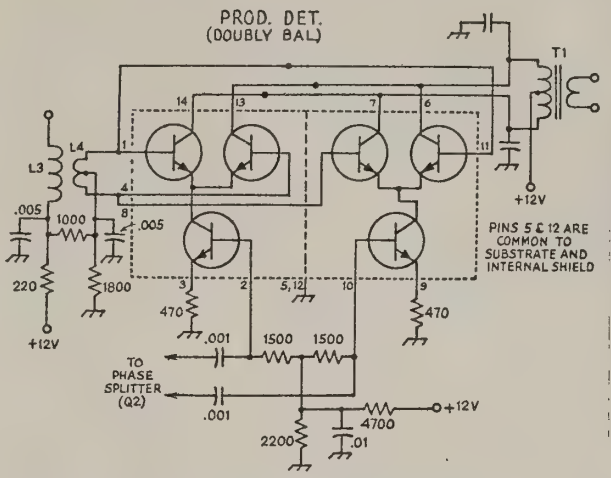
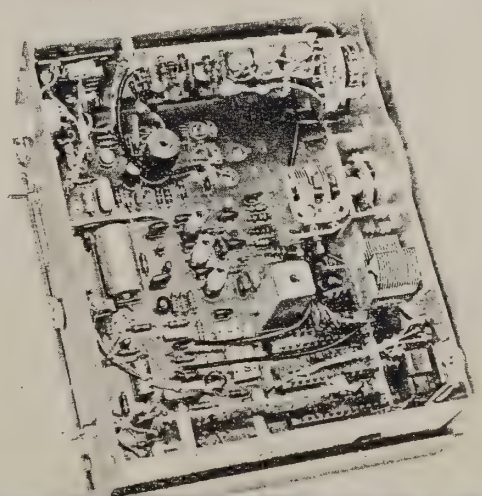


Fig. 2 — Schematic diagram in internal portion of the CA3021E transistor-array IC, illustrating how the sections are connected for doubly balanced detector service. The CA3049T is the same electrically, but does not have the built-in shield between the differential pairs. The latter is housed in a TO-5 package.



The new receiver section is visible at the upper right, just to the left of the band switch. A MFJ Enterprises cw filter is mounted left of the receiver board, with leads going to a rear-panel switch which cuts the filter out of the circuit when desired. The circuit of Fig. 3 can be used in place of the MFJ filter and will fit into the same area. At the lower center is the W7ZOI keyer module mounted on standoff posts. The toggle switch at lower left is for transmitter tuneup, as mentioned in the text.

[1] MFJ Enterprises, Box 494Q, Mississippi State, MS 39762 (see *QST* advertisement, p. 168, Sept. 1973).

Some Other Modifications

This writer was never pleased with the side-tone and muting characteristics of the HW-7. Therefore, two simple changes were made to remedy the problem. A bipolar switch was added to the audio line for muting (Fig. 3), and the side-tone output was routed directly to the headphone jack. The W7ZOI QRP keyer was added to the HW-7 as an operating convenience.[2] The speed control is mounted on the front panel, just above the rf gain control. A miniature toggle switch was installed on the rear panel to lock the transmitter in the OPERATE position during tuneup. Kurz-Kasch aluminum knobs were installed to dress up the appearance, though the original knobs are entirely suitable.

The 2N2222 muting transistor, Q3 of Fig. 3, is saturated when the antenna relay of the break-in delay circuit is energized, thereby blanking out the receiver audio during transmit periods. Any npn switching transistor with electrical characteristics similar to the 2N2222 will be suitable at Q3. The writer mounted Q3 by its leads, directly across the pc-board foils near the af gain control. A knife was used to cut an isolating pad in the ground foil near Q3. The base lead, associated 22,000-ohm resistor, and .005-μF capacitor were connected to the pad after drilling a small hole through it for the base lead. A similar pad was cut approximately 0.5 inch (1.27 cm) away from the first one to provide an anchor point for the remaining lead of the base resistor, and for attaching the wire which connects to the hot side of RL1.

[2] Hayward, "An Integrated-Circuit QRP Keyer," *QST* for November, 1971. Circuit board and layout information available from W7ZOI for $3. Write to W. Hayward, 7700 S.W. Danielle Ave., Beaverton, OR 97005.

The *RC* active filter is mounted adjacent to the new front end assembly, near the rear panel of the HW-7. Those wishing to make their own pc boards can combine the two circuits on a single board if desired.[3]

All unused components from the original detector circuit (L1, C1, C2, C3, C4, R1-R5, incl., Q1, and jumper X-U) are removed from the pc board. Replace C13 with a 0.33-μF unit. The additional capacitance at C13 knocks down the unwanted high-frequency response in the audio channel (hiss noise and high-pitched heterodynes) to improve the overall selectivity and noise figure.

Performance Notes

Prior to modification a discernable cw note could be heard when applying a 0.8-μV signal at the receiver input (15 meters). Slightly greater sensitivity was observed on 20 and 40 meters (approximately 0.6 μV). Response with the new front end is just under 0.1 μV on all three bands for the same level of af output.

Cross-modulation characteristics were measured at 7 MHz, before and after modification, by inserting and listening to a 10-μV signal, then applying another signal 25 kHz away from the one being monitored. Before modification, cross modulation occured when the second signal was elevated to 3000 μV. A 40,000-μV signal is required to cause cross modulation in the new front end. The unmodified receiver was subject to strong-signal

[3] Check suppliers of pc board for availability and price of the boards used in this project: D.L. McClaren, W8URX, 19721 Maplewood Avenue, Cleveland, OH 44135; Charles R. Sempirek, K8WDC, Rt. 3, Box 1, Bellaire, OH 43906; Spectrum Research Laboratory, Inc., P.O. Box 5824, Tucson, AZ 85703.

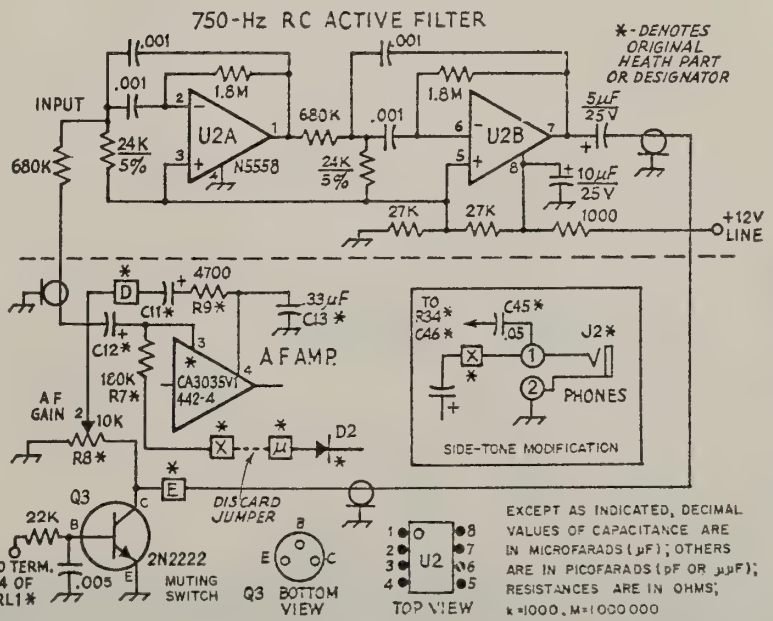


Fig. 3 — The diagram above the dashed lines shows the electrical circuit for the N5558 *RC* active cw filter. The .001-μF capacitors should be the close-tolerance, temperature-stable type. Silver micas are suitable. Polystyrene capacitors were used in writer's model. Resistors should be 5-percent, 1/4-W composition units. The circuits below the dashed line illustrate modifications to the original HW-7 circuit. The inset drawing shows the change made in the side-tone circuit.

desensitization (25-kHz signal separation) when 2000 μV of signal was supplied. The new receiver does not begin to show evidence of desensing until 10,000 μV of signal is applied. As the operating frequency is increased the before-and-after characteristics just listed deteriorate slightly. Although the figures given for the new circuit are not spectacular as compared to those of many modern-day superheterodyne receivers, the writer considers them suitable for such a simple circuit. Certainly the performance is much better than it was before the modifications were made.

Future Changes?

Basically, the VFO and transmitter sections of the HW-7 are quite good from a design and performance point of view. Only two areas need improvement: The frequency offset between transmit and receive leaves much to be desired. The output wave form has sufficient harmonic energy in it to cause TVI in fringe areas.

These offset amounts were measured with a frequency counter in the ARRL lab, and were the same before and after modification: (1) 7 MHz = 36 Hz. (2) 14 MHz = 380 Hz. (3) 21 MHz = 575 Hz. Ideally, an offset between 600 Hz and 1 kHz would make the transceiver compatible with most other transceivers on the market. The narrow offset will prevent the signal from being heard in many instances, and especially on 40 meters. Stations which use separate transmitters and receivers can manage the HW-7 situation without difficulty, provided the operator at the other end does a bit of receiver tuning after he calls CQ.

The unfortunate fact of the matter is that the HW-7 designers relied upon the difference in VFO output loading between the transmit and receive modes to shift the operating frequency. The loading (or pulling) effect becomes less pronounced as the operating frequency is lowered. No doubt an offset circuit that could be controlled from the front panel, during receive periods only, would be the expedient needed to solve the problem. Such a circuit could be patterned after those applied in many of the commercially made transceivers being used today. Addition of an RIT (receiver incremental tuning) circuit would be advantageous even if the HW-7 were equipped for a specific fixed-value offset for each band, as is the case with the more elaborate transceivers.

In treating the TVI matter the practical approach would be to install a high-quality low-pass filter at the antenna jack of the HW-7. Half-wave low-pass filters such as those described by McCoy in *QST* for April, 1968, page 26, would be suitable for minimizing TVI caused by harmonic energy. Those wishing to design their own filters can use toroidal inductors and thereby make the filter assembly relatively compact. By designing for a loaded Q (Q_L) of 1, and a bilateral impedance of 50 ohms, the X_C and X_L will be 50. A cascaded two-section pi network of that type (half-wave filter) will provide ample bandwidth and should clean up all but the most stubborn cases of TVI. Three half-wave filters (40, 20, and 15 meters) could be installed inside the HW-7 and switched for the appropriate band, or they could be constructed in a Minibox (with band switch) and used outboard.

Summarization

Constructors who are interested in laying out a pc-board pattern of their own can probably make the module smaller than the one described here.[4] There is no reason why 1/4-watt resistors can't be used in most sections of the circuit. Also, the RCA CA3049T can be used in place of the CA3021E with good results. The former comes in a TO-5 package and has identical characteristics to the '3021E.

This article was not meant to imply that the HW-7 in its original form is of poor quality. It is, in the writer's opinion, a fine bargain in terms of cost *versus* portability and performance. However, there are few commercial or homemade amateur products that can't be improved in some manner, and that was the object of this exercise in circuit development. Meanwhile, if some reader discovers a simple way to convert the HW-7 direct-conversion receiver to a superheterodyne, let's hear from you! QST

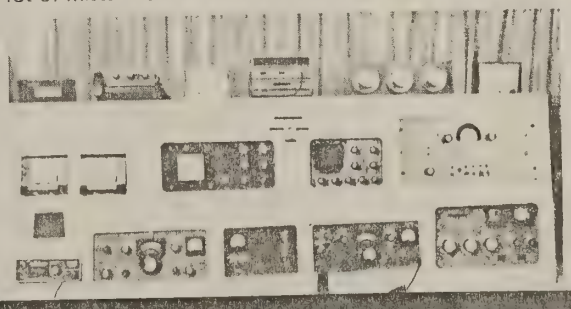
[4] Scale templates and parts layout for the pc boards are available from ARRL for 50 cents and a large s.a.s.e.

Strays

The comet Kohoutek is providing amateur radio with a unique opportunity to help improve communications between people around the world. The Kohoutek Intergalactic Net (KIN) is linking together comet watchers, celebrations, observatories, scientists, and comet cruises and flights in those countries permitting third-party communications. The Earth Society, which is sponsoring the "Kohoutek Comet Watch" cruises, sees KIN as an excellent way to tie together comet observers.

If you can set up an exhibit at a comet event, or handle phone patch traffic (or for any other reason), you are invited to join KIN on 14,300 kHz at 0000 GMT (7 P.M. EST) daily and on 3900 kHz (and 146.94 MHz locally) during hours of comet visbility (early evening). For more information, contact: Wes Thomas, W2IKQ, 606 5th Ave., E. Northport, NY 11731.

When I visited League headquarters, I noticed the Collins console that you were using at W1AW. I liked the idea and the color so I came home and built one. I am a long way from being a carpenter, but with vinyl tile and white filler you can hide a lot of mistakes. — *WA4ZRX*



MFJ ENTERPRISES

P. O. BOX 494, MISSISSIPPI STATE, MS. 39762

HINTS IN OBTAINING MAXIMUM PERFORMANCE FROM ACTIVE AUDIO FILTERS

MFJ high performance active filter results from careful application of modern network synthesis theory and modern IC technology. The following hints will enable you to attain maximum performance.

●NO IMPEDANCE MATCHING REQUIRED

NO IMPEDANCE MATCHING IS REQUIRED for optimum filter response. However, the source impedance driving the filter should be less than one-tenth the filter input impedance. This requirement is generally satisfied without considering the source impedance since MFJ filters are designed for very high input impedance.

THE FILTERS CAN DRIVE 500 OHM OR GREATER LOADS, such as high impedance phones, without distortion. Lower impedances such as 8 ohm phones can also be driven. If distortion occurs, reduce the input signal level or transform the impedance up to 500 ohms or greater. For example, a minature audio transformer (500 ohms to 8 ohms) can be used to couple 8 ohm phones to the filter.

●INSTALLATION OF FILTERS

THE SIMPLEST METHOD of using the CW and SSB filters is to plug the filter into the phone jack or connect it to the speaker terminals of your receiver or transceiver and use headphones at the filter output. This gives very satisfactory performance and is the normal mode of operation.

FOR FULL SPEAKER OPERATION, install the filter between audio stages as shown in Figure 1. Installation after the first gain stage helps to avoid the problems of possible oscillations, hum pickup, and noise.

SHIELDED CABLE AND PROPER GROUNDING MAY BE NECESSARY to prevent hum pickup and audio oscillations, particularly if the filter is used before a very high gain amplifier. The filter PC board may be physically mounted inside the receiver and power taken from the receiver.

CARE MUST BE TAKEN so DC bias conditions within the receiver audio amplifier are not upset (i.e. do not remove biasing resistors or place the filter between direct coupled stages, etc.).

DC VOLTAGES AT THE FILTER INPUT must not exceed the input capacitor rated voltage. DC voltage at the output must not exceed 1/2 of the filter power supply voltage.

SUMMARIZING, connection to the receiver optput is recommended for simplicity of installation and for checking out the filter. For full speaker operation install the filter between audio stages. Alternately, a power amplifier can be installed after the filter to drive a speaker.

●POWER REQUIREMENTS

THE BX MODELS (filters installed in cabinets) require a 9 volt battery. Be sure to remove the cabinet top and install a battery before using.

ALL MFJ FILTERS (except the LPF-2) are designed to perform equally well from 6 VDC to 30 VDC. This may be supplied from batteries, a well filtered power supply, or "stolen" from the receiver.

IF A 500 OHM OR GREATER LOAD IS USED and distortion occurs but disappears at low volume, increase the power supply voltage (stay within the 30 volt limit).

●GROUNDING

PROPER GROUNDING IS NECESSARY, particularly if a battery or other floating power source (i.e. neither positive or negative side is at signal ground) is used. One side of the supply must be connected to signal ground. Generally, the negative side of the floating source is connected to the receiver chassis ground. If the CW filter is not connected to the receiver signal ground, a very broad response may occur instead of a very narrow response.

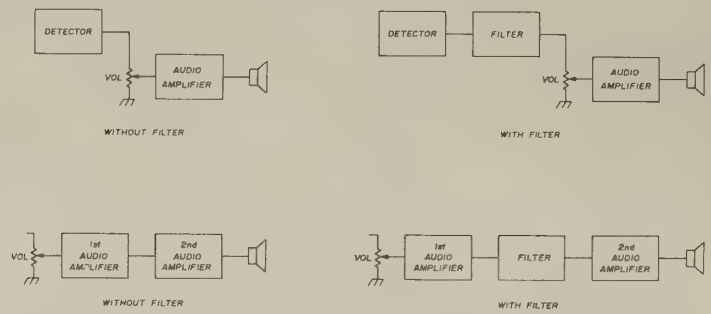
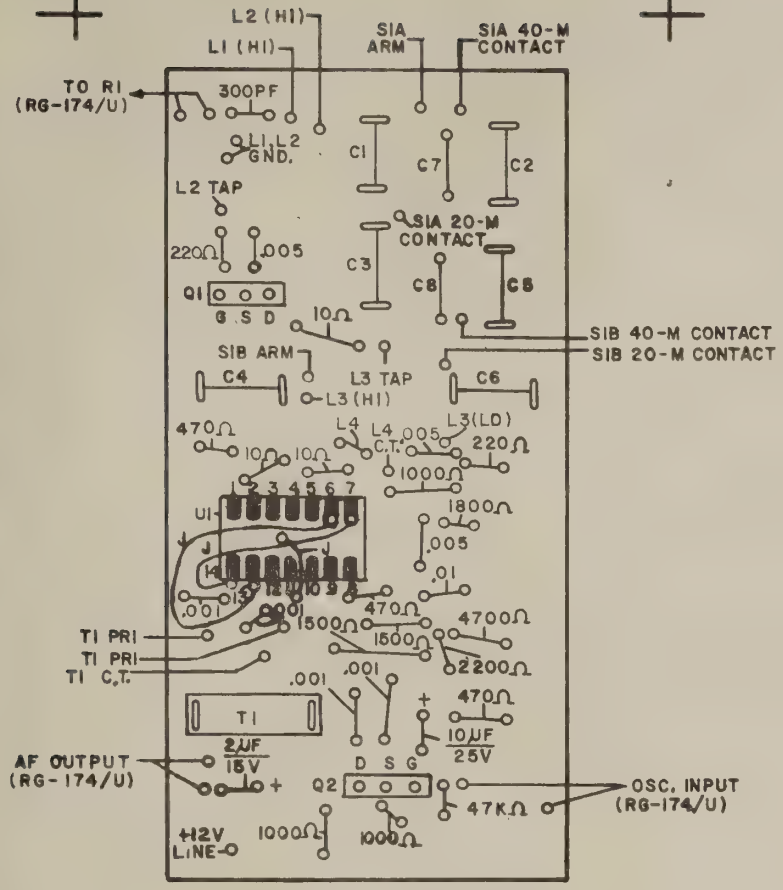
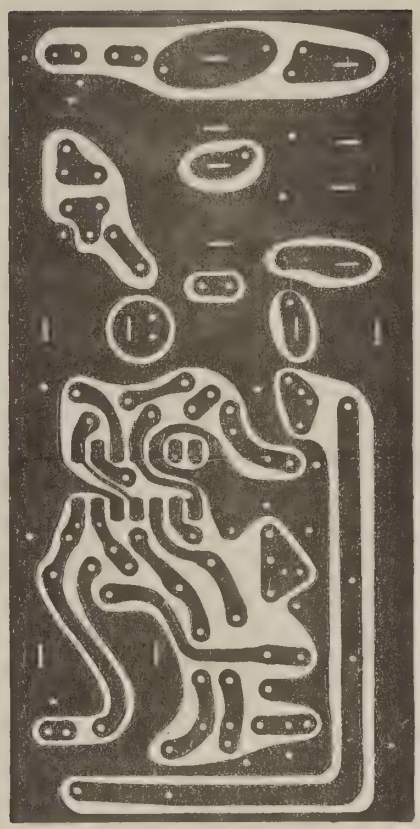


fig.1 . Method of connecting the CW and ssb filters. Better performance results if filters are inserted ahead of the audio amplifier.

●SYNOPSIS OF MFJ ACTIVE AUDIO FILTERS

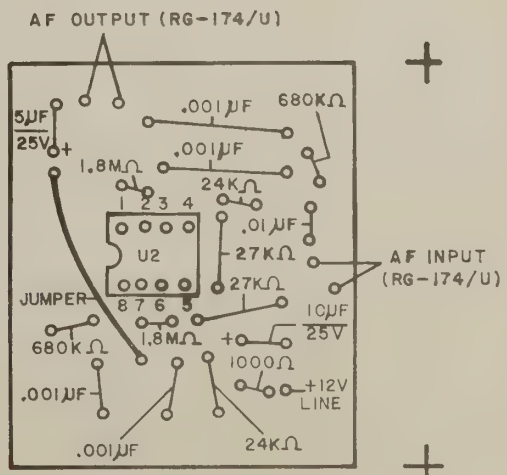
CW FILTERS: CWF-2BX, CWF-2 ● 8 poles ● Bandwidths (selectable)-180,110, 80 Hz ● Ultra steep skirts-60 db down 1 octave from center frequency of 750 Hz (80 Hz bandwidth) ● 400 or 1000 Hz center frequency optional CWF-3 ● 4 poles ● Bandwidths (selectable)-180, 110 Hz ● 30 db down 1 octave from 750 Hz center frequency
SSB FILTER: SBF-2BX, SBF-2 ● 8 poles, total ● Selectable (1.) high pass cutoff 475 Hz and low pass cutoffs (2.) 2.5, (3.) 2.0, (4.) 1.5 KHz ● 120 db per decade rolloff in 1.5 KHz position
LOW PASS FILTER: LPF-1 ● 8 poles ● 160 db per decade rolloff ● Presettable cutoff 500 to 20,000 Hz ● 1 Meg input impedance LPF-2 ● Identical to LPF-1 except cutoff extends to DC, requires dual polarity supply LPF-4 ● 4 poles ● 80 db per decade rolloff ● Presettable cutoff 500 to 20,000 Hz
HIGH PASS FILTER: HPF-4 ● 4 poles ● 80 db per decade rolloff ● Presettable cutoff 300 to 20,000 Hz ● Remove high power low frequency speech components for increased talk power
WIDE BAND PASS FILTER: BPF-1 ● Consist of a LPF-4 and HPF-4 on 2x3 inch PC board ● Upper and lower cutoff frequency independently presettable for audio bandshaping
NARROW BAND PASS FILTER: NBP-2 ● 2 stages, each stage individually tunable from 300 to 3000 Hz (trim pots) ● 200 Hz bandwidth over tuning range ● Can be staggered tuned ● Excellent RTTY filters





JUMPERS, C7 AND C8 ARE MOUTED ON FOIL SIDE OF BOARD

QRP MODS FOIL SIDE (FULL SCALE)



HW-7 MODS. RC ACTIVE FILTER FOIL SIDE (FULL SCALE)

R_1, R_4, R_7, R_{10}; 680.K ohms (Blue, gray, yellow)

R_2, R_5, R_8, R_{11}; 24.K ohms (red, yellow, orange)

R_3, R_6, R_9, R_{12}; 1.8M ohms (Brown, gray, green)

R_{13}, R_{14} ; 24.K ohms (red, yellow, orange)

C_1 ; .01uf (disk)

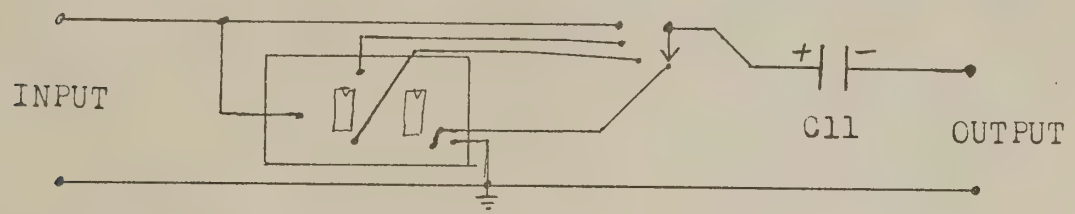
C_2 through C_9 ; .001uf (transparent)

*C_{10} ; 5.uf (electrolytic)

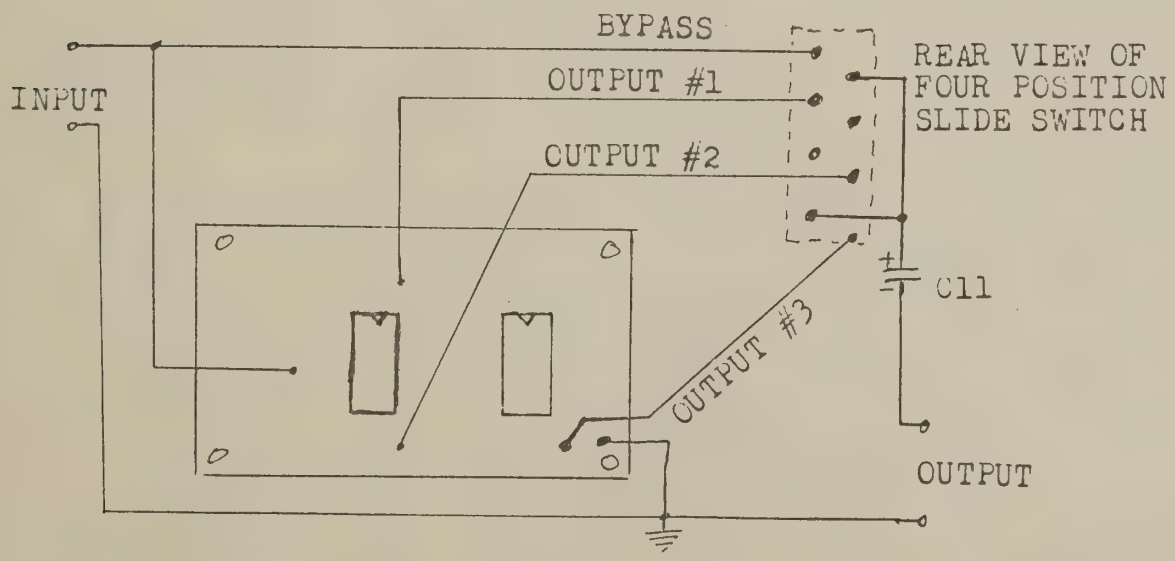
*C_{11} ; 5.uf (electrolytic)

(5) Wire the power divider R_{13}, R_{14}, and C_{10} (note correct polarity direction on drawing.) Solder C_1 in place.

(6) Wire leads to the + Power, ground, input, output #1, output #2, and output #3. The input and three outputs should be wired to a 4 position single pole switch as shown. C_{11} (5 uf) is wired beyond the switch (note polarity) in order to block the DC level (1/2 of + Power) which appears on each output.



(7) If you use a 4 position slide switch then wire the filter as below:



*AVAILABLE VALUE

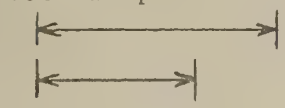
MFJ ENTERPRISES

P. O. Box 494, Mississippi State, MS 39762

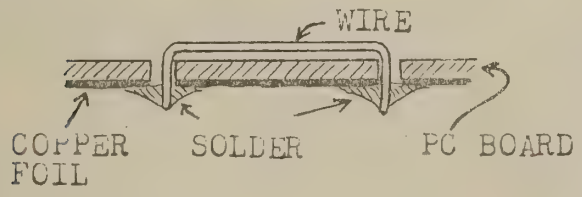
CWF-2 CODE FILTER CONSTRUCTION

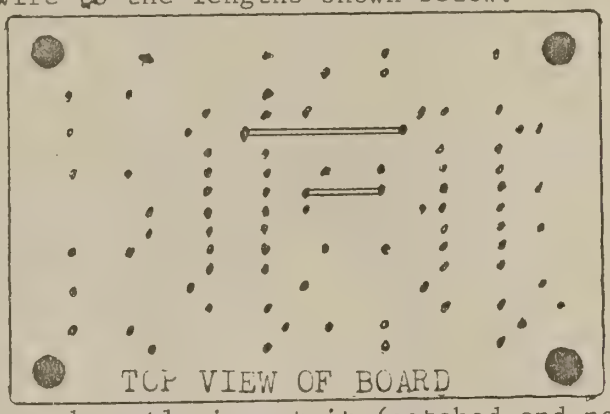
(1) Use only a low wattage iron (27 watt). Do NOT use a 100 watt gun! Use rosin core solder, not acid core. Do not hold your iron on a copper foil terminal for longer than 5 sec. The solder will melt in 1 or 2 seconds, but the iron should remain in contact with the solder joint until the liquid solder "wets" both the foil AND the component lead. The balls of liquid solder appear to lose their surface tension all at once and flow over the metal surfaces.

(2) Cut two pieces of bare or insulated wire to the lengths shown below.



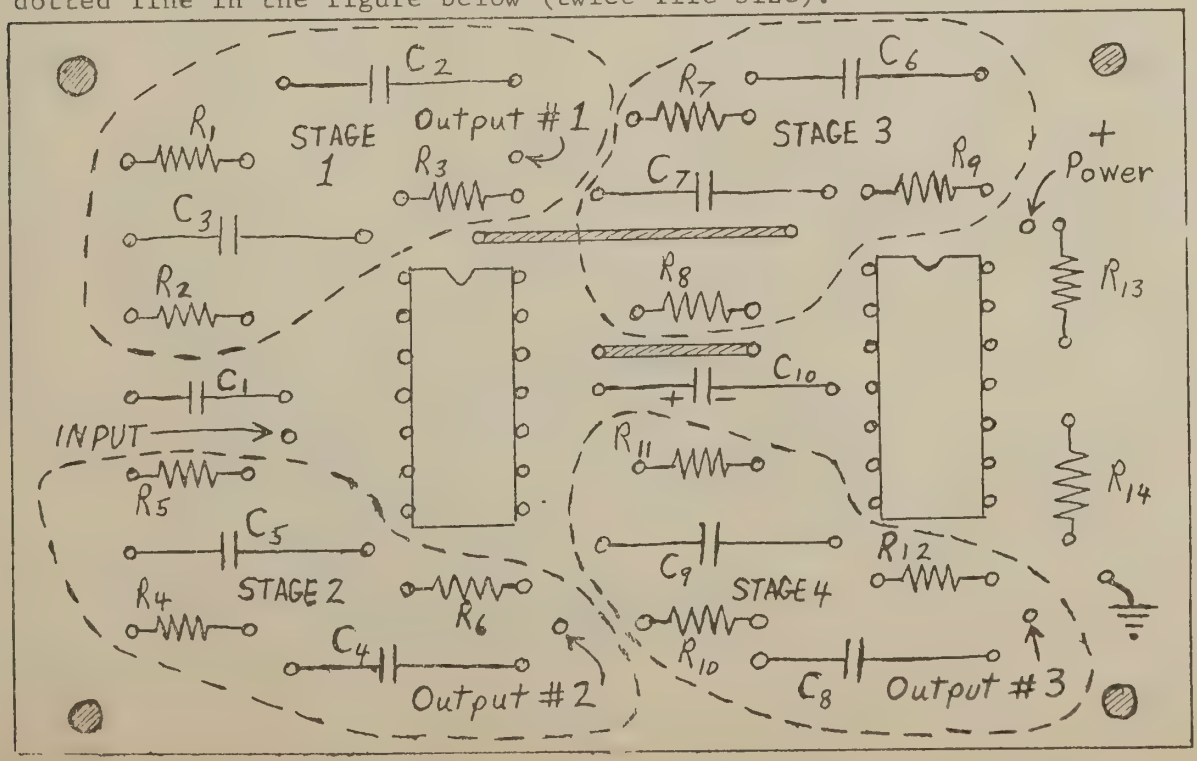
Solder as shown on the PC board.





(3) Remove one IC op amp from its carrier and gently insert it (notched end near the top) into either of the two positions on the PC board. The op amps and other components are always mounted on the side of the board which has no copper foil on it. Slight bending adjustments may need to be made to the pins in order to mate with the hand drilled holes. Press the body of the IC as close as possible to the PC board without deforming the pins of the IC. Use care in soldering the IC so that it is not overheated. Now, insert and solder the other IC.

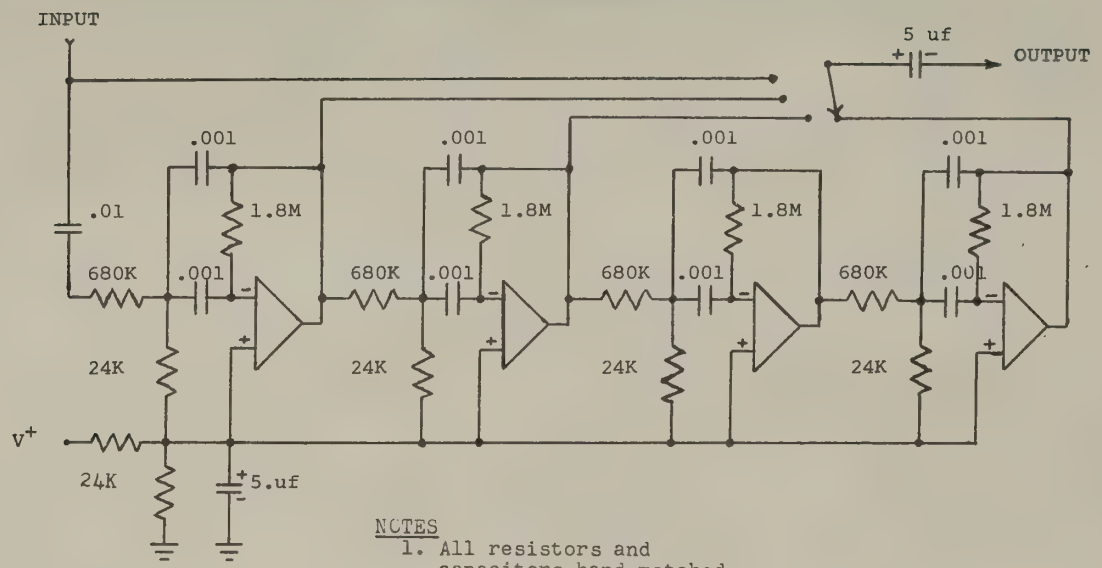
(4) The CWF-2 filter is made up of 4 identical stages in cascade. The components of each stage have been hand selected for optimum performance. Do not mix the components of one stage with those of another. Position and solder one stage before starting another stage. Each stage has been circled by a dotted line in the figure below (twice life size).



NEW HIGH PERFORMANCE

CW Filter

MODEL CWF-2



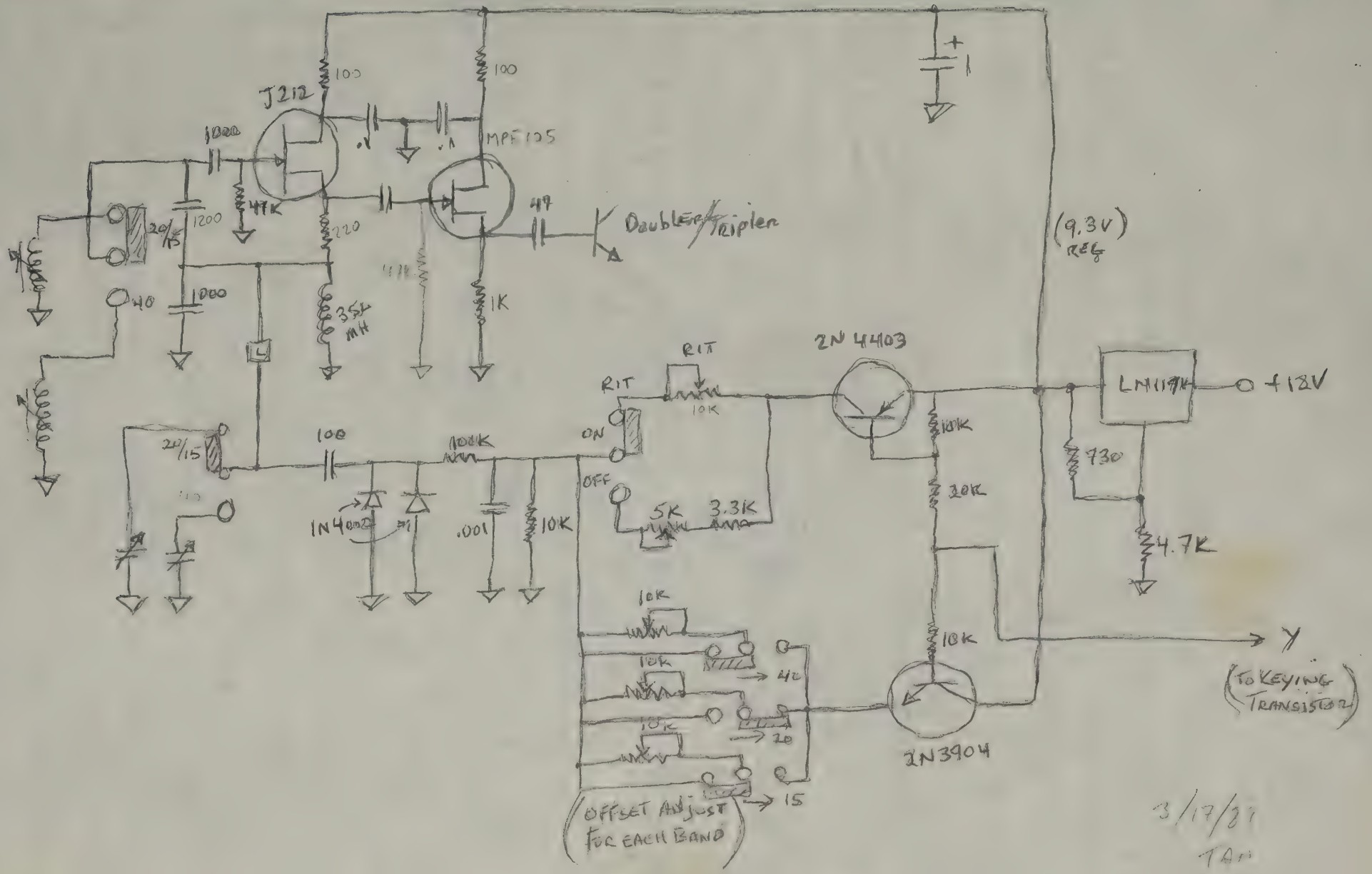
NOTES

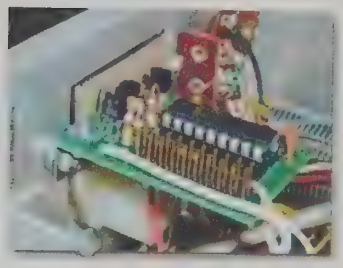
1. All resistors and capacitors hand matched for same center freq.
2. Op amps are 747's.

MFJ ENTERPRISES

P. O. Box 494, Mississippi State, MS 39762

RIT Mod for HW-7





Installing the Freq-Mite in the Heathkit HW-8

by William Eric McFadden

Mounting Freq-Mite Circuit Board & Circuit Ground:

Using the supplied right-angle bracket, I mounted the Freq-Mite to the HW-8 inner front-panel at the meter mounting screw located nearest to the VFO capacitor. Because the mounting hole on the Freq-Mite circuit board is also a ground pad, circuit ground is achieved mechanically through this mount. Figure 1 shows an overall view of the mounting location. Figure 2 is a closer view of the mounting scheme.

Figure 1 (click image to enlarge)

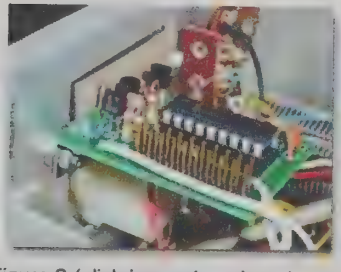


Figure 2 (click image to enlarge)

Button:

The button is a momentary-contact, normally-open pushbutton. To mount the button, I drilled an appropriately-sized hole in the back of the cabinet about an 1.25" above the key socket. Figure 3 shows the button mounted in this hole. From the S1 and GND pads on the Freq-Mite, I ran a twisted-pair of wires to the button. These wires are visible in Figures 1 and 2. Because there's a mechanical connection to chassis ground at the Freq-Mite mount, the GND wire is probably not necessary for operation of the device.

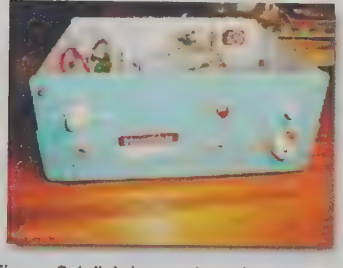


Figure 3 (click image to enlarge)

RF Pickup:

The RF signal for the Freq-Mite is picked up at the HW-8's Test Point 2 (TP2). This is located at the leg of R49 nearest to the large inductor L9 in the middle of the transciever's main circuit board. For this connection, I soldered directly to R49's leg. In Figure 4, the RF pickup is the blue wire.

Figure 4 (click image to enlarge)

AF Out:

The audio-output signal from the Freq-Mite is connected to the center connection of the transceiver's AF-gain potentiometer through the supplied 100k-ohm resistor. Please note, the HW-8 uses concentric controls for on-off, AF-gain, and RF-gain. The AF-gain potentiometer is the middle of these three controls. The center connection of the potentiometer is the AF-gain output. By using this connection instead of the input, the Freq-Mite audio level remains constant--the transceiver volume can be turned all the way down for easy copy of the Freq-Mite. In figure 4, the white wire is the Freq-Mite AF Out.

Figure 5 (click image to enlarge)

12v DC

DC power for the Freq-Mite is achieved with a connection to the output of the transceiver's on-off switch. This switch is the rear-most of the three concentric controls described above, and the output is the terminal with the yellow wire going to point E on the transceiver's main board. In figure 5, the DC power connection is the smaller red wire. (The larger red wire brings transceiver power from the six-pin Molex connector on the back of the rig.)

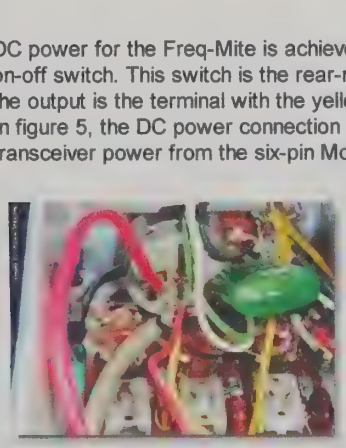


Figure 6 (click image to enlarge)

Jumpers and Operation:

Because of the HW-8's direct-conversion design, no offset jumpers need to be installed on the Freq-Mite. Upon application of power to the transceiver, the Freq-Mite sends "s?". Press the button once if you want readout to be at 26wpm instead of the default 13wpm. The Freq-Mite will send "i?" to ask if the frequency calculation should be inverted. Do not press the button since you don't want the calculation to be inverted. Finally, the Freq-Mite will send the prosign "AR". Any button-press at this point will cause the Freq-Mite to send the least three significant digits of the frequency. (Example: with the transceiver 40m band switch depressed and the VFO dial set to 100 for a selected frequency of 7.100 MHz, a button press will cause the Freq-Mite to send "100". If band noise prevents copy of the Freq-Mite, turn the transceiver's AF gain down all the way and press the button again.

VISHAY SILICONIX - 2N4416-E3 - N-CHANNEL JFET AMPLIFIER

Manufacturer: VISHAY SILICONIX
Newark Part Number: 06J8868
Manufacturer Part No: 2N4416-E3
NOTE-Exact replacement for **13C1992**
RoHS Compliance : **Yes**

Description

- N-CHANNEL JFET AMPLIFIER
- Transistor Type:JFET
- Breakdown Voltage, V(br)gss:-36V
- Gate-Source Cutoff Voltage Max, Vgs(off):-6V
- Power Dissipation, Pd:300mW
- Operating Temperature Range:-55°C to +150°C
- No. of Pins:4
- RoHS Compliant: Yes

Availability

Availability: 200
Price For: 1 Each
Minimum Order Quantity: 1
Order Multiple Quantity: 1
Price: $4.78

Qty 1 BUY

Price

Qty	Price
1 - 24	$4.78
25 - 99	$4.33
100 - 249	$3.90
250 - 499	$3.55
500 - 999	$3.23
1000 - 2499	$3.01
2500+	$2.91

PRODUCT INFORMATION

RoHS Certificate of Compliance

Datasheet

Get ADOBE READER

PRODUCT ATTRIBUTES

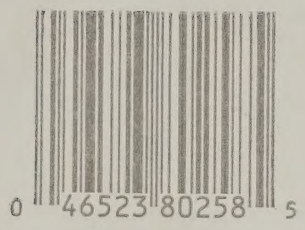
SIMILAR PRODUCTS

- Transistor Type: JFET
- Breakdown Voltage, V(br)gss: -36V
- Gate-Source Cutoff Voltage Max, Vgs(off): -6V
- Power Dissipation, Pd: 300mW
- Operating Temperature Range: -55°C to +150°C
- Transistor Case: TO-206AF
- No. of Pins: 4

FIND SIMILAR

Web Site Support:
1.800.NEWARK.T (1.800.639.2758)

Contact Newark:
1.800.4.NEWARK (1.800.463.9275)



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